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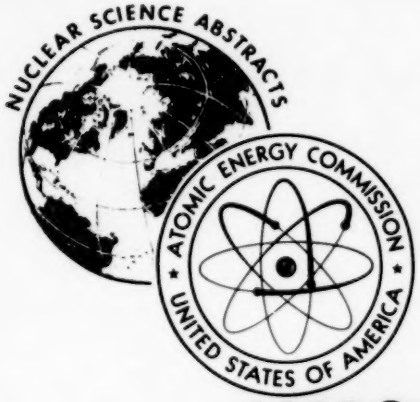

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Volume 18, Number 2, January 31, 1964

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Volume 18, Number 2 January 31, 1964

NUCLEAR SCIENCE ABSTRACTS

BIOLOGY AND MEDICINE

General

Refer also to abstract 2404.

1319 (NP-13300) VARIATION IN REFLECTANCE OF VEGETATION AND SOILS CAUSED BY AN UNDERGROUND NUCLEAR EXPLOSION. Final Technical Report. Stephen E. Dwornik, Donald G. Orr, and Leonard M. Young (Army Engineer Research and Development Labs., Fort Belvoir, Va.). Nov. 1, 1962. 83p.

A portable reflectance spectrophotometer was used to obtain vegetation and soil reflectance data from 250 to 200 mμ in order to determine the effect of underground nuclear explosions on vegetation at the Nevada Test Site. It was anticipated that reflectance differences would show up on aerial photographs and might serve as an on-site inspection technique. In order to determine the optimum film–filter combinations, basic reflectance data were collected before and after underground explosions. A comparison of reflectance curves after one blast revealed there may have been a change in vegetation reflectance in the infrared that persisted for 8 or 9 days after the detonation. After this period, reflectance values became normal. Samples a mile away from the blast did not exhibit this change. No changes were observed after several other blasts. The effects of seasonal changes, soil moisture content, instrument variations, and combinations of these factors on results of reflectance measurements are discussed. (C.H.)

1320 (NP-13315) ANNUAL REPORT OF ASSOCIATION EURATOM-ITAL, 1962. (Netherlands. Instituut voor Toepassing van Atoomenergie in de Landbouw, Wageningen). Sept. 1963. 35p.

The status of radiation research in the fields of botany and agriculture during 1962 is reviewed. Emphasis was placed on mutation breeding programs, the behavior of radioisotopes of Sr and Cs in soil and plants, and the development of methods for radiation processing of foods. Brief accounts of symposia and training programs are included. (C.H.)

1321 (NP-13317) FOURTH REPORT. For [Years] 1961 and 1962. (Norsk Hydro's Inst. for Cancer Research, Oslo). 1963. 58p.

Research activities of the Norsk Hydro's Institute for cancer Research during 1961 and 1962 are summarized. Studies were conducted in the fields of radiobiology, pathology, genetics, biochemistry, and biophysics. A list is included of 122 papers published, or in press, as a result of the research programs. (C.H.)

1322 (TID-19622) SPONTANEOUS AND RADIATION MUTAGENESIS AND MUTABILITY IN DROSOPHILA. Final Report. (Saint Louis Univ.). 1963. Contract AT (11-1)-633. 18p.

Progress is reported in studies on the transgeneration transmission of nutrients through the egg or sperm of Drosophila, the effect of various nutrients in the growth medium on mutation rate in Drosophila, nonrandom assortment of nonhomologous chromosome elements in male Drosophila melanogaster, and chromosome arrangement in mature sperm of Drosophila. (C.H.)

1323 (TID-19670) A NITROGEN MUSTARD DERIVATIVE OF 6-MERCAPTOPURINE. Gershon Levin, Kanematsu Sugiura, and George Bosworth Brown (Sloan-Kettering Inst. for Cancer Research, New York and Cornell Univ., New York. Medical Coll.). [1963]. Contract AT(30-1)-910. 9p.

The carcinostatic effects of a nitrogen mustard derivative of 6-mercaptopurine were tested for 17 mouse tumors. The antitumor activity of the compound paralleled that of nitrogen mustard and was less effective than 6-mercaptopurine. (C.H.)

1324 (TID-19683) PHYSIO-PATHOLOGY OF PLATELETS AND THE DEVELOPMENT OF PLATELET EXTRACTS AND SUBSTITUTES. Annual Progress Report, January 1, 1963–December 31, 1963. (New England Center Hospital, Boston). Nov. 10, 1963. Contract AT (30-1)-1276. 18p.

Buffered sodium citrate was used in the collection of human blood platelets. The platelets were labeled with Cr^{51}, reinjected, and used as tracers to investigate the site of platelet destruction by scanning the accumulation of radioactivity over the spleen and liver of normal persons and those with idiopathic thrombocytopenic purpura. Results were used to evaluate the effectiveness of drug therapy in this disease. Preliminary studies on isoimmunity to blood platelets in rabbits, dogs, and humans are reported. Data are included from studies of antigens and antibodies in blood platelets and the interaction of viruses with blood platelets. (C.H.)

1325 (UCRL-10934) BIO-ORGANIC CHEMISTRY QUARTERLY REPORT, MARCH–MAY 1963. (California. Univ., Berkeley. Lawrence Radiation Lab.). July 29, 1963. Contract W-7405-eng-48. 146p.

Research progress in bio-organic chemistry is reported. Topics covered include: fertility and litter size of normally ovulated and artificially ovulated mice, sterility produced in male mice by deuterium oxide, planarian disaggregation, uptake of organic compounds by planarians,

acetylcholinesterase and cholinesterase activity in rat brain, brain chemistry and anatomy among mature rats, paper chromatographic techniques for labeled cell extracts, measurement and adjustment of pH in small volumes of solutions, C^{14} and N^{15} tracer studies of amino acid synthesis during photosynthesis by Chlorella pyrenoidosa, photosynthesis of C^{14}-labeled protein from $C^{14}O_2$ by Chlorella, studies on carboxydismutase, electron microscopy of chlorophyll a crystals, possible role of chromanyl phosphates in oxidative and photosynthetic phosphorylation, oxidation-reductions of some coenzymes, preparation of some C^{14}-labeled compounds, attempts to synthesize high-molecular-weight polynucleotides using Schamm's purely chemical method, optical properties of some dye-polyanion complexes, mechanism of thymine dimerization, ultraviolet irradiation of aqueous $HC^{14}N$, ultraviolet and infrared spectra of some ortho-nitroamides, reflection spectra of bio-organic materials in the 2.5 to 4 μ region and interpretation of the infrared spectra of Mars, electron spin resonance of crystalline chlorophyll a, optical properties of polymers, interaction between Mn(IV) hematoporphyrin IX and water, variation of electron paramagnetic resonance signals of photosynthetic systems with redox level of their environment, absorbance changes in bacterial photosynthesis, low-temperature electron-paramagnetic-resonance studies, theoretical and instrumental comments on magnetic optical rotatory dispersion. (M.C.G.)

1326 (FTD-TT-63-968(p.326-31)) EFFECT OF THE SPACE FLIGHT CONDITIONS IN VOSTOK-3 ON SEEDS OF HIGHER PLANTS. L. K. Gordon, N. L. Delone, V. V. Antipov, and V. G. Vysotskii (Vysotskiy). Translated from Kosmich. Issled., 1: No. 1, (July-Aug. 1963).

Evidence is cited which shows that the conditions of space flight affect the viability of certain higher plants, causing stimulation or inhibition of germination. Beans and pine demonstrated a tendency toward an increase in the number of chromosomal rearrangements. (auth)

1327 (FTD-TT-63-968(p.332-41)) FURTHER STUDY OF THE EFFECT OF SPACE FLIGHT CONDITIONS ON THE CHROMOSOMES OF THE PRIMARY ROOTLETS OF GERMS IN PEA AND WHEAT SEEDS. V. V. Khvostova, S. A. Gostimskii (Gostimskiy), V. S. Mozhaeva (Mozhayeva), and L. V. Nevzgodina. Translated from Kosmich. Issled., 1: No. 1, (July-Aug. 1963).

The effect of space flight conditions on the chromosomes of peas and wheat, the seeds of which were on the Vostok-3, was studied. Also, the effect of vibrations and high-energy protons was investigated to determine the factors that act during a space flight. It was demonstrated that under space flight conditions a small, but statistically significant increase in the per cent of chromosomal rearrangements is observed in cells of the rootlets of the germs of air-dried wheat and pea seeds. The increase in the rearrangement % does not depend on the flight duration. (auth)

1328 THE PREPARATION OF ^{131}I-LABELED HUMAN GROWTH HORMONE OF HIGH SPECIFIC RADIOACTIVITY. F. C. Greenwood (Imperial Coll. of Science and Tech., London), W. M. Hunter, and J. S. Glover. Biochem. J., 89: 114-123(Oct. 1963).

A simple and rapid method is presented for the preparation of I^{131}-labeled human growth hormone of high specific radioactivity (240-300 μC/μg). Low amounts of carrier-free I^{131} iodide (2 mC) are allowed to react, without prior treatment, with small quantities of protein (5 μg) in a high-yield reaction (approx. 70% transfer of I^{131} to protein). The degree of chemical substitution is minimized (0.5-1.0 atom of iodine/molecule of protein) by the use of carrier-free I^{131} iodide. The I^{131}-labeled hormone (up to 300 μC/μg) contains no detectable degradation products and is immunologically identical with the unlabeled hormone. The loss of immunological reactivity at high specific radioactivities or at high levels of chemical substitution with [I^{127}]iodine is demonstrated. (auth)

1329 LYMPHOCYTES: THE MACKENZIE DAVIDSON MEMORIAL LECTURE. J. F. Loutit (Medical Research Council, Harwell, Berks, Eng.). Brit. J. Radiol., 36: 785-94(Nov. 1963).

Recent research findings on lymphocytes are reviewed in relation to anatomy, histology, circulation, function, trophic concept, immunology, hematopoiesis, the thymus, and leukemia. (H.M.G.)

1330 THE SITES AND RELATIVE FREQUENCIES OF SECONDARY CONSTRICTIONS IN HUMAN SOMATIC CHROMOSOMES. M. A. Ferguson-Smith, Marie E. Ferguson-Smith, Patricia M. Ellis, and Marion Dickson (Glasgow Univ. and Johns Hopkins Univ., Baltimore). Cytogenetics, 1: 325-43(1962).

Karyotype analyses made from photomicrographs of 1303 human somatic cells derived mainly from peripheral leucocyte cultures obtained during the investigation of patients for chromosome aberrations, have been re-examined in order to determine the sites and relative frequencies of secondary constrictions. It has been confirmed that the chromosomes showing secondary constrictions most frequently in this material are chromosomes 13. 14, 15, 21, and 22. In these five pairs, a secondary constriction in the short arm separates a terminal mass, the satellite, from the rest of the chromosome arm. Secondary constrictions were also observed at specific sites in other chromosomes, although less frequently. In chromosomes 1, 6, 9 and 17 the constriction peculiar to each appeared in over 20% of the available chromosomes of the respective chromosome pair. Examples of secondary constrictions in these and other chromosomes are illustrated. Our observations provide evidence of at least fifteen sites, where constrictions are visible at a definite point with sufficient frequency to exclude any explanation other than that they are a distinct entity, characteristic for each chromosome. For each of these 15 constrictions, 10 chromosomes have been measured and the distance from the centromere to the constriction determined. The characteristic site of each constriction is indicated in a normal human idiogram constructed from chromosome measurements in 10 selected male cells. The value of secondary constrictions in the identification of human chromosomes is discussed, and the importance of recognizing their location and variable appearance is stressed in view of the possibility that they may on occasions be interpreted as evidence of chromosome aberration. (auth)

1331 AN ARTIFACT IN THE PAPER CHROMATOGRAPHY OF RADIOIODIDE. Alvin Taurog (Univ. of Texas, Dallas). Endocrinology, 73: 581-7(Nov. 1963).

Preparations of Oak Ridge radioiodide were diluted with glass-distilled water and applied to filter paper strips for chromatography. Spontaneous drying of the applied samples for 10-20 min before the papers were placed in the chromatography jar resulted in variable, and sometimes very marked (up to 70%), transformation of the radioiodide. At least three different non-iodide components were formed. These changes were largely prevented by drying in a nitrogen atmosphere, and were completely inhibited by 3×10^{-4} M methimazole. An oxidative mechanism is therefore suggested. Addition of 3×10^{-4} M carrier iodide also greatly

reduced the chemical changes occurring on drying. This, coupled with the variability of the effect, suggests that a trace component of the atmosphere, whose concentration varied from day to day, was involved in the reaction. These findings raise the possibility that other labile compounds, in addition to iodide, may also undergo oxidative changes when very dilute solutions are dried on filter paper. (auth)

1332 DNA SYNTHESIS IN RELATION TO CHROMOSOME REPRODUCTION AND THE REUNION OF BREAKS. J. Herbert Taylor (Columbia Univ., New York). J. Cellular Comp. Physiol., 62: Suppl. 1, 73-86(Oct. 1963).

A model of DNA by Taylor is discussed. The chromosome is visualized as a tandem-linked series of replicons, segments of DNA which replicate as units, coupled by 3′R and 5′R linkers (replicon linkers) in such a way that there is a reversal in polarity in each chain at the junctions. During the condensed stages of division in large chromosomes the long strand is assumed to be coiled, folded and stabilized by H linkers that may give the chromatids a temporary doubleness during division stages. The model described serves as a basis for discussion of results on breakage, reunion, and repair processes in relation to DNA synthesis. Since there is at present no way to test the model directly, its usefulness in predicting and interpreting results on breakage, reunion and genetic recombination may serve to indicate its reality or to suggest necessary modifications. (auth)

1333 ELECTROPHORETIC METHOD FOR OBTAINING NUCLEOTIDES LABELLED WITH RADIOACTIVE CARBON. T. Borkowski, H. Bruzuszkiewicz, and H. Berbec (Medical Academy, Lublin, Poland). J. Chromatog., 12: 229-35(Oct. 1963).

Conditions for separating adenosine, guanosine, cytidine, and uridine monophosphates (AMP, GMP, CMP, and UMP) by means of continuous electrophoresis on Whatman 3 MM filter paper in acid buffer at pH 3.5 are described. The ribonucleotides of RNA obtained in this way were tested with regard to their purity. The method can be used for the production of the four mononucleotides on a laboratory scale. Good results were obtained for the production of nucleotides from biosynthetically labeled RNA of E. coli grown on a synthetic medium in the presence of CO_2^{14}. The radioactive mononucleotides were found to be labeled in the purine and pyrimidine bases only. The specific activity of the four mononucleotides was similar. (auth)

1334 A DIGITAL-COMPUTER METHOD FOR RAPID RADIOACTIVITY CALCULATIONS. F. S. Eberts, Jr. and E. P. Markovich (Upjohn Co., Kalamazoo, Mich.). J. Nucl. Med., 4: 462-8(Nov. 1963).

Computer programs are described that were designed for the calculation of drug-distribution data. The actual mathematical equations employed are quite general and may be applied in any case where a radioactive material is distributed in a multi-component system, such as an animal or a fractionation process. This is accomplished simply by assigning a different meaning to a given constant or variable, or, if preferred, by changing the designation of constants or variables in the computer program. Routine use of these programs indicated that almost any tracer experiment lends itself to automatic computation techniques based on the programs described and that the number of samples to be calculated usually determines whether the computer is used. The problems cited were solved for RECOV, expressed as percent of administered dose; however, certain problems by their nature cannot be solved for this term but for some other value such as CPMT or DPMT. (auth)

1335 AN EARTHWORM LABELLED WITH RADIOACTIVE TANTALUM. B. M. Gerard (Rothamsted Experimental Station, Harpenden, Herts, Eng.). Nature, 200: 486-7(Nov. 2, 1963).

An adult Lumbricus terrestris L. (live weight 5.3 g) was labeled with 2.0 mg of radioactive tantalum wire (Ta^{182}) in its coelom through a slit cut laterally in the second segment behind the clitellum and apparently suffered no ill effects. Three months later the Ta was found in a segment 1 in. from the anus. The worm could be detected when it was 8 in. below the surface of the soil in its vertical burrow by a mains-operated G-M monitor. (P.C.H.)

1336 INDUCTION BY 5-FLUOROURACIL OF BACTERIOPHAGE DEVELOPMENT IN LYSOGENIC E. COLI K12 (λ). Herbert Marcovich (Institut Pasteur, Paris) and Henry S. Kaplan. Nature, 200: 487-8(Nov. 2, 1963).

E. coli K12 (λ), strain B-40, streptomycin-sensitive was grown to about 5×10^8 cells/ml at 37°C in modified Davis mineral medium to which 0.8% glucose and 5 mg/ml vitamin-free casein hydrolysate were added. Preliminary experiments in which E. coli K12 (λ) were incubated for at least 60 min in the presence of high concentrations (50–100 μg/ml) of 5-fluorouracil (FU) or its deoxyriboside (FUDR) revealed that a burst of phage production occurred after the subsequent addition of thymine (T) or thymidine (TdR) plus uracil (U) or uridine (UR). In the presence of FU alone, an initial decrease in phage titre was found, followed within 30–60 min after the addition of TdR by a sharp rise that attained levels about 1000-fold higher in approximately 1 hr. In another experiment the addition of TdR to FU containing cultures at 90 min was followed within 1 hr by a sharp burst of phage production; the response was completely prevented when the same concentration of TdR was added at 0 min. Thus it was found that the initial step in phage induction by FU requires a period of time for the action of the analogue in the absence of T or TdR. (P.C.H.)

1337 DISTURBANCE IN THE PROLIFERATION AND DIFFERENTIATION OF MONONUCLEAR LEUCOCYTES TO FIBROBLASTS IN DIFFUSION CHAMBERS BY DEUTERIUM OXIDE. Nicholas L. Petrakis, Mary Davis, and Benjamin V. Siegel (Univ. of California, San Francisco). Nature, 200: 591-2(Nov. 9, 1963).

The effects of D_2O on theproliferation and differentiation of mononuclear leukocytes to fibroblasts were investigated. Mice were fed water containing 30% D_2O prior to starting the experiments. The results indicated that the capacity of mesenchymal mononuclear leukocytes of blood to proliferate and afterwards to differentiate to fibroblasts in diffusion chambers is impaired when normal leukocytes are implanted in subcutaneous tissue environments rich in D_2O. Also, complete failure of growth and differentiation resulted when leukocytes from deuterated hosts were cultivated in either normal or deuterated mice, suggesting that deuterium oxide is deleterious to the capacity for differentiation of mesenchymal leukocytes in physiologically nontoxic concentrations. (P.C.H.)

1338 RADIOAUTOGRAPHIC EFFICIENCY FOR TRITIUM AS A FUNCTION OF SECTION THICKNESS. Gretchen J. Falk and R. C. King (Northwestern Univ., Evanston, Ill.). Radiation Res., 20: 466-70(Nov. 1963).

Data are presented relating radioautographic efficiency to section thickness which indicate that increased efficiency compensates in part for decreasing radioactivity in increasingly thin sections. It is suggested that most workers can improve radioautographic resolution by cutting thinner

sections and coating these with thin films of suitably diluted liquid nuclear emulsion. (auth)

1339 COLLECTION AND HANDLING OF BONE MARROW SUSPENSIONS FOR INTRAVENOUS USE. A. Boyum (Rikshospitalet, Oslo). Scand. J. Clin. Lab. Invest., 14: 419-24(1962).

Techniques employed in the transplantation of bone marrow for the treatment of bone marrow aplasia caused by radiation or chemical compounds are described. Procurement of bone marrow suspensions must ensure that the suspension will be sterile, homogenous (without clumps), and contain an adequate number of cells to build up rapidly an aplastic marrow to near normal function. The bone marrow is aspirated into syringes containing acid-citrate-dextrose and the material is then pooled in a plastic transfer pack of 600 ml. The pack is then centrifuged bottom up for 5 min at 1000 rpm (200 g). This brings the fat to the top, and the fatty layer is clamped off. The bone marrow cells are then transferred through a 250 μm mesh screen to a new plastic pack. With aspirated human bone marrow suspensions, at least some of the megakaryocytes passed the filter, but it was not possible to determine the loss of megakaryocytes quantitatively since their number was too small in the suspension. To study this question, bone marrow was collected from rat femur and tibia, and suspended in citrated rat blood. Samples passed through stainless steel screens with meshes of 400, 250, and 105 μm, respectively, showed no significant reduction in the number of megakaryocytes after filtration, nor were there any striking changes in their morphology. A direct proportionality was found between the volume of blood/marrow mixture aspirated and the content of nucleated cells. However, this is true only if the aspirations are done with the needle in many different positions within the marrow cavity. A large volume may easily be aspirated with the needle in one position, but this will mainly be peripheral blood. It appears, therefore, that there is little use in withdrawing more than 10 ml in each position of the needle, and 5 ml should be the rule. To obtain $5\text{-}10 \times 10^9$ nucleated cells, it is necessary to aspirate not less than 200 ml. The donor should be 20-40 years old, healthy, and rather slim. Donor and recipient should be of the same phenotype as to erythrocyte antigens, or they should not differ by more than 1 or 2 antigens; they should preferably be related. The aspiration can be done under local anesthesia with premedication, but general anesthesia is preferable. The marrow is withdrawn by multiple aspirations via a cortical hole in the posterior iliac spine, and by 4-6 aspirations from the sternum. In addition, aspirations can be made from the posterior iliac crest, anterior iliac spine, and anterior iliac crest. The details of the procedure are presented in stepwise form. (BBB)

Ecology

1340 (TID-19529) RADIOACTIVITY TRANSPORT IN WATER—BEHAVIOR OF RUTHENIUM IN ALGAL ENVIRONMENTS. Technical Report No. 4. W. E. Bolch and E. F. Gloyna (Texas. Univ., Austin. Environmental Health Engineering Research Lab.). Sept. 1, 1963. Contract AT(11-1)-490. 65p.

Results are reported from an investigation of the factors involved in the transport of Ru by a common aquatic microorganism. Chlorella pyrenoidosa was chosen to determine the uptake of nitro nitrosylruthenium and ruthenium chloride. This alga was chosen because it is a prolific organism, particularly in nutrient rich streams. It is believed that this organism's role in the aquatic transport of certain radionuclides will become more significant. Factors which appear to contribute to the transport by algae were derived from preliminary investigations in five environmental systems. The algal environments were altered by various combinations of light, carbon dioxide, nutrients, bacteria, live algal cells, and dead algal debris. Ruthenium-106 was used to trace the fate of the ruthenium compounds. Evidence was found for the presence of two possible methods of transport; namely, surface sorption typical of ion exchange and sorption typical of loosely adsorbed aggregates of the ruthenium compounds on algal cells. The factors which appear to affect the degree and method of transport are discussed. (auth)

1341 (TID-19608) SPECIES COMPOSITION AND DISTRIBUTION OF MARINE NEKTON IN THE PACIFIC OCEAN OFF OREGON. Final Progress Report, September 1, 1961 through September 1, 1963. (Oregon State Univ., Corvallis. State of Science). Contract AT(45-1)-1726. 156p.

Studies were made over a 2-yr period of the distribution, ecology, and radioactivity of oceanic nekton and macroplankton in the Pacific Ocean off the Oregon coast. The role of fishes, squids, shrimps, euphausiids, and other swimming animals in the accumulation and biological transport of nuclides in ocean waters was investigated. Data are included on the species composition of oceanic marine nekton and macroplakton; the distribution of animals in regard to spatio-temporal differences related to depth and diurnal vertical migration, distance from shore, latitude, and seasons of the year; and the collection and identification of oceanic animals for analysis for radioisotopes formed by neutron activation at the Hanford reactors and passed to the ocean by waters of the Columbia River. The content of Zr^{95}–Nb^{95}, Zn^{65}, Cr^{51}, Ce^{141}, Ru^{103}, Co^{60}, K^{40}, Mn^{54}, Cs^{137} in marine animals from various ocean depths and in relation to the Columbia River plume and seasons was determined. Sampling and analytical methods are described. (C.H.)

1342 (JPRS-21816) DISTRIBUTION OF RADIOISOTOPES IN BASIC COMPONENTS OF FRESH-WATER BODIES. Elena Aleksandrovna Timofeeva-Resovskaya. Translated from Tr. Inst. Biol., Akad. Nauk SSSR, Ural'sk. Filial, No. 30, 1-79(1963). 104p. (OTS-63-41112)

Results are reported from a series of studies of the distribution of radioactivity from 18 different radioisotopes in surface waters, sediments, and aquatic organisms. Emphasis was placed on the concentration of the various radioisotopes by freshwater organisms. The radioisotopes investigated included P^{32}, S^{35}, Cr^{51}, Fe^{59}, Co^{60}, Zn^{65}, Ge^{71}, Rb^{86}, Sr^{90}, Y^{91}, Zr^{95}, Nb^{95}, Ru^{106}, Cd^{115}, I^{131}, Co^{137}, Ce^{144}, and Hg^{203}. (187 references.) (C.H.)

Metabolism, Tissue Distribution, and Toxicology

1343 (UR-634) IMMUNOLOGICAL REMOVAL OF CIRCULATING I^{131}-LABELED RABBIT ANTIBODY TO RAT FIBRINOGEN IN NORMAL AND TUMOR-BEARING RATS. Irving L. Spar, Ruth L. Goodland, and Mary Ann Desiderio (Rochester, N. Y. Univ. Atomic Energy Project). Oct. 18, 1963. Contract W-7401-eng-49. 35p.

Purified I^{131} rabbit antibody to rat fibrinogen is substantially removed from circulation using goat antiserum to rabbit gamma globulin. Subsequent studies on I^{131} activ-

ity in organs of such rats show considerable immediate deposition of the radioactivity in the liver and somewhat less in the spleen; this is eliminated in 6 to 12 hr. I^{131} determination on Murphy-Sturm tumors in such immunologically treated animals demonstrate little, if any, loss of tumor deposited I^{131} for the first 24 hr. The bearing of these results on scintillation scanning techniques for tumors and thrombi is discussed. (auth)

1344 (AEC-tr-6137) URANIUM IN THE HUMAN ORGANISM. Josef Hoffmann. Translated by Barbara Fritsche (National Lead Co. of Ohio, Cincinnati), from Wien. Klin. Wochschr., 54: 1055-9(Dec. 26, 1941).

Uranium traces in human bones and organs were separated by chemical methods and results obtained using a fluorescence microscope are reported. The detection of U traces in the bony framework and in urine indicates that U is transported in the blood. (C.H.)

1345 PLACENTAL TRANSFERS: MODERN METHODS OF STUDY. Joseph Sternberg (Univ. of Montreal). Am. J. Obstet. Gynecol., 84: 1731-48(Dec. 1, 1962).

Advantages and disadvantages in the use of radioisotopes in the study of placental permeability are presented. The study of placental permeability with radioisotopes is discussed in terms of three categories: quantitative studies: what is transferred; quantitative studies: how much is transferred and how fast does it pass; localization studies: where and how does it cross the placental barrier; advantages of various half-life times and types of radiation are also dealt with. Experimental results obtained with the following isotopes are reviewed: D, C^{14}, F^{18}, Na^{22}, Na^{24}, S^{35}, K^{42}, Ca^{45}, Cr^{51}, Fe^{59}, Co^{60}, Zn^{65}, Br^{82}, Kr^{85}, Rb^{86}, Sr^{89}, Mo^{99}, Ru^{105}, I^{125}, I^{131}, I^{132}, Ba^{133}, Cs^{137}, Ce^{144}, Po^{210}, Rn^{222}, Ra^{226}, and Pu^{239}. Placental transfer and the fetal uptake of the commonly found radioactive contaminants of the environment are also discussed. These include radioactive elements detected in air or water pollution, those produced by fission of U^{235}, or those rendered radioactive by the neutrons released after fission. The placental membrane is able to discriminate between some periodic relatives, which may be an additional mechanism of protection for the fetus. Another group of radioactive contaminants, belonging to the family of rare earths, behave as colloids and are withdrawn from circulation by the mother, even before they reach the placenta. Radioactive elements which can cross the placental barrier damage fetal tissues according to their respective metabolic role or to their affinity for nonmetabolites. The amount of Sr^{90} transferred during pregnancy is negligible compared to that taken up by the newborn. The present concentration of tritiated water in the biosphere is negligible from the point of view of radiation damage. The possible influence of an increased C^{14} level is still a matter of controversy, but a further increase could lead to a parallel increase of genetic damage. (BBB)

1346 EFFECTS OF CHELATING AGENTS ON RADIOIRON ABSORPTION AND DISTRIBUTION IN RATS IN VIVO. J. M. Hopping and W. S. Ruliffson (Kansas State Univ., Manhattan). Am. J. Physiol., 205: 885-9(Nov. 1963).

Effects of ethylenediaminetetraacetate (EDTA), citrate, ascorbate, succinate, and sorbitol on the absorption and postabsorptive distribution of $Fe^{59}Cl_3$ in the rat were studied, using an isolated loop technique. Citrate most effectively promoted iron absorption, with ascorbate, EDTA, and succinate following in that order. Sorbitol seemed without effect. Control animals with access to food until time of experiment absorbed more radioiron than did fasted controls. Partial trypsin hydrolysis permitted demonstration that succinate-exposed gut cells most avidly retained iron, while EDTA led to least cellular retention. Postabsorptive distribution among blood, liver, spleen, long bones, kidneys, and urine was unremarkable except that EDTA promoted marked radioiron urinary excretion. EDTA may pass through the gut wall as an intact iron chelate. A pattern of actions during iron absorption is proposed for EDTA, citrate, ascorbate, and succinate. (auth)

1347 EFFECT OF NICOTINE ON CARDIAC MUSCLE CONTRACTIONS AND RADIOCALCIUM MOVEMENT. Winifred G. Nayler (Baker Medical Research Inst., Melbourne). Am. J. Physiol., 205: 890-6(Nov. 1963).

Nicotine, 0.01–0.1 mM, evoked a positive inotropic response and abolished the staircase and poststimulation potentiation in toad ventricular muscle; 0.2 mM nicotine caused the development of contracture, whether or not extracellular Ca^{2+} was present; and 1.0 mM nicotine enhanced the uptake and release of Ca^{45} from the muscle. It seems probable that the effect of nicotine on the contractile response of cardiac muscle can be related to the mobilization of Ca^{2+}. (auth)

1348 STUDIES ON STRONTIUM METABOLISM IN MAMMALIAN BONE. W. A. Mueller (Institut für Strahlenschutzforschung, Neuherberg, Ger.). Atompraxis, 9: 408-11(Oct. 1963). (In German)

Stable Sr is excreted from the bones of mice in one or two phases, depending on whether the animal's skeleton is already saturated with Sr or not. Animals pre-fed with stable Sr took up larger quantities of orally administered radiostrontium in their bones than did untreated control animals. This is attributed to the course of excretion of Sr from the skeletal system, and to changes in the Sr/Ca discrimination factor in the gastro-intestinal tract. (auth)

1349 THE REMOVAL OF Sr^{85} AND Ca^{45} FROM BONE IN VITRO. Joseph Samachson and Hilda Lederer (Veterans Administration Hospital, Hines, Ill. and Montefiore Hospital, New York). Arch. Biochem. Biophys., 103: 168-74 (Nov. 1963).

Defatted bone powder, anorganic bone, ashed bone, and apatite which had taken up Ca^{45} and Sr^{85} under different conditions were subjected to wash solutions after standing for different lengths of time or after being subjected to heat treatment. A number of factors affected the ratio of Ca^{45} removed to Sr^{85} removed, but under a given set of conditions a change in the ratio could be used as a criterion of recrystallization. The decrease in amounts removable after different periods of standing could be ascribed primarily to processes occurring in the organic matter of bone, and to a lesser extent in the hydration layer and on the crystal surface. There was no evidence of genuine recrystallization at room temperature. (auth)

1350 THE AGE DEPENDENCE OF THE POTASSIUM AND CESIUM-137 CONTENT OF MEN. Erich Oberhausen (Universität Saar, Homburg, Ger.). Biophysik, 1: 135-42 (1963). (In German)

The K and Cs^{137} content was determined with a 2-π whole-body counter on 12,000 persons at ages of 5 to 70 yr from June 1959 to December 1962. It is shown that both the K and the Cs^{137} content are dependent on sex and age. By consideration of the data given in the literature on the concentration in total water, conclusions on the K concentration in the lean body mass and the different composition of the lean body mass at various ages could be drawn. Measurements of the Cs^{137} concentration in adults gave a constant ratio between Cs^{137} and K; that in women was about

12% lower than in men. In children this ratio is lower by a factor of 2. (tr-auth)

1351 BIOLOGICAL HALF-LIFE OF TRITIUM. K. F. Wylie, W. A. Bigler, and G. R. Grove (Mound Lab., Miamisburg, Ohio). Health Phys., 9: 911-14(Sept. 1963).

An 8.5-day biological half life for tritium was determined for seven occurrences in six males. A method for estimating the average whole-body water is presented. An average body-water to effective-body weight ratio of 0.60 was calculated. (auth)

1352 NATURAL OCCURRENCE OF UNSUPPORTED RaF (Po^{210}) IN TISSUE. C. R. Hill (Inst. of Cancer Research, Belmont, Surrey, Eng.). Health Phys., 9: 952-3 (Sept. 1963).

The source of Po^{210} in the kidneys of sheep that had grazed in a high rainfall area in Wales is discussed. The relation of fallout to tissue content of Po^{210} is considered. (C.H.)

1353 DISTRIBUTION OF RADIOACTIVITY IN THE RAT AFTER ADMINISTRATION OF [C^{14}]-d,l-α-TOCOPHERYL ACETATE. U. Gloor, F. Weber, J. Wuersch, and O. Wiss (F. Hoffmann-La Roche & Co., AG, Basel). Helv. Chim. Acta, 46: 2457-60(1963). (In German)

The radioactivity in various organs of rats was determined after peroral administration of 2 and 5 mg [C^{14}]-d,l-α-tocopheryl acetate at intervals of half an hour to 88 days. In all the organs examined, radioactive α-tocopherol was found in concentrations of 0.1 μg/g (blood) to 3.1 μg/g (brain), even 88 days after administration. The adrenals and hypophysis were found to be especially enriched with α-tocopherol. (auth)

1354 SYNTHESIS AND BEHAVIOR OF NUCLEAR PROTEINS DURING THE CELL LIFE CYCLE. D. M. Prescott and M. A. Bender (Oak Ridge National Lab., Tenn.). J. Cellular Comp. Physiol., 62: Suppl. 1, 175-94(Oct. 1963).

Migration of nucleus-specific proteins between the nucleus and cytoplasm during interphase and mitosis was studied. Experiments were carried out on Chinese hamster cell line CHEF-125 and Amoeba proteus. CHEF-125 cells were incubated with a pulse of H^3-thymidine and metaphases collected with colchicine at intervals during the next 48 hours; so that the first, second, third, and fourth division metaphases could be studied for segregation of labeled DNA. A series of four proliferating cultures were labeled with tritiated uridine. To make a more quantitative study of nuclear protein, a combination of tritium labeling, autoradiography, and micrurgy was performed with the amoeba cultures. Labeled DNA in a mammalian cell type was found to segregate in a precise, semiconservative manner as originally described by Taylor, Woods, and Hughes. Labeled proteins in metaphase chromosomes at the first and second mitoses after labeling segregated approximately equally between sister chromatids. The labeled proteins were completely lost from the chromosomes in three or four cell cycles. Labeled RNA was divided about equally between chromatids at the first metaphase after labeling. Labeled RNA was almost absent from chromosomes in the second metaphase after labeling and completely absent at the third metaphase. All nuclear proteins in amoeba were found to turn over continuously during an experimentally prolonged interphase. No protein (including histone) could be detected that remained a permanent, fixed part of the nucleus. Virtually all labeled proteins in the nucleus of amoeba were released to the cytoplasm during mitosis. These proteins rapidly returned to the nucleus in late telophase and early interphase. (auth)

1355 TAGGED ISOMERS AND ANALOGUES OF THYROXINE (THEIR TRANSMISSION ACROSS THE HUMAN PLACENTA AND OTHER STUDIES). John E. Kearns and William Hutson (Evanston Hospital, Ill. and Northwestern Univ., Evanston, Ill.). J. Nucl. Med., 4: 453-61(Nov. 1963).

Results are reported from studies of the transmission of thyroxine, its analogs and isomers, through the placental membrane using I^{131} as a tracer. Some physiological properties of tagged isomers and analogs of thyroxine are reported. It was concluded that they are decreased in cord blood although there is complete transmission of NaI^{131}. There seems to be a specific distributional difference between thyroxine and triiodothyronine in its collections in body areas. Excretion in bile and rapid re-absorption in the gut were shown. (auth)

1356 THE BROMIDE SPACE AFTER THE INTRAVENOUS ADMINISTRATION OF ^{82}Br. C. T. Howe and R. P. Ekins ([Middlesex Hospital, London]). J. Nucl. Med., 4: 469-79(Nov. 1963).

After the intravenous administration of Br^{82} in man, the isotope was completely distributed after 2 hr and the volume of distribution remained stable for at least 12 hr. A selectively high concentration of Br^{82} in the gastric contents was confirmed. An average of 20% of the administered dose was secreted into the stomach in 12 hr. If allowance was made for this dose loss into the stomach, in addition to that lost in the urine, the extracellular fluid volume determined by this method represented 22.6% of the ideal body weight and the correlation between the two is closer than when the loss of isotope into the stomach is unknown. It is suggested that the intravenous administration of Br^{82} is a rapid and accurate method for measuring the extracellular fluid volume, provided that the gastric loss of isotope over the period of equilibration is known. (auth)

1357 ISOTOPIC LABELING OF THE RAT PARATHYROID AS DEMONSTRATED BY AUTORADIOGRAPHY. E. James Potchen (Peter Bent Brigham Hospital, Boston). J. Nucl. Med., 4: 480-4(Nov. 1963).

The rat parathyroid was isotopically labeled with relative selectivity using tritiated methionine as demonstrated by autoradiographic techniques. The parathyroid function was stimulated by a low calcium diet. Thyroid anabolism, which is the most probable source of extraneous radioactive emission, was effectively suppressed with thyroxine. This initial breakthrough in selective isotopic labeling of the parathyroid glands has many ramifications some of which are discussed. (auth)

1358 THE TECHNIQUE OF DETERMINING THE RADIATION DOSES ABSORBED DURING WHOLE-BODY ALPHA THERAPY AND SOME RESULTS FOR PERORAL ADMINISTRATION OF RADON WATER. S. V. Andreev. Med. Radiol., 8: No. 9, 69-76(Sept. 1963). (In Russian)

A method for studying the distribution of Rn, RaA, RaB, and RaC in major organs and tissues of the animals is described, as well as a technique used for determining absorbed radiation doses during the administration of radon into the organism. Experimental curves of accumulation and excretion (decay) of these isotopes, as well as the absorbed radiation doses in major organs and tissues of albino rat during peroral administration of radon water into the stomach are given. On the basis of the data, a tentative recalculation of the absorbed radiation doses for human organs and tissues was made. (auth)

1359 STRONTIUM–CALCIUM DISCRIMINATION BY THE HUMAN PLACENTA. Joseph Rivera (U. S. Atomic Energy Commission, New York). Nature, 200: 269-70 (Oct. 19, 1963).

Measurements were made of the Sr–Ca discrimination in human beings by determining the concentration of stable Sr in serum from blood taken from the fetal and maternal sides of the placenta at birth. If the Ca concentration of the blood on either side of the placenta is assumed to be the same, then the ratio of the stable Sr concentration in the infant's serum to that of the mother is a measure of placental discrimination. The average concentration of stable Sr in the mothers' sera was found to be 0.10 μg/ml with a standard deviation of 0.06 μg/ml. The average concentration of stable Sr in the new-born infants' sera was 0.08 μg/ml with a standard deviation of 0.04 μg/ml. The ratios of the concentration of stable Sr in the serum of the newborn to that of the mother ranged from 0.26 to 2.53. The average and standard deviation of the ratios was 0.89 ± 0.57. After removing two cases considered atypical, the average values were: mothers' sera 0.10 ± 0.05 μg/ml; new-borns' sera 0.07 ± 0.03 μg/ml; and new-born/mother sera of 0.82 ± 0.38. (P.C.H.)

1360 SKIN REACTION TO INTRADERMAL INJECTION OF RARE EARTHS. Thomas J. Haley and Harvey C. Upham (Univ. of California., Los Angeles). Nature, 200: 271(Oct. 19, 1963). (TID-19448)

The intradermal injection of 0.05 ml of aqueous solutions of 1×10^{-4}–1×10^{-6} concentrations of Pr, Nd, Eu, Dy, Ho, Er, or Lu chlorides in guinea pigs resulted in the formation of 2mm diameter nodules containing crystalline deposits. Observation for periods of 45 days showed no decrease in nodule size or any resorption of the crystalline deposits. Differential staining of histological sections indicated the presence of histiocytes and foreign body giant cells surrounding the crystals with fibroblasts and granulation tissue extending into the area. (P.C.H.)

1361 CESIUM-137 BODY BURDEN IN PERSONS CHOSEN AT RANDOM FROM SELECTED AREAS IN NORWAY. Kjell Madshus (Norsk Hydro's Institute for Cancer Research, Norway). Nature, 200: 278-9(Oct. 19, 1963).

The Cs^{137} body burden and content in milk in Norway was determined. A detailed study of the milk from Masfjorden showed that its Cs^{137} content showed a first decided increase in June, rising all summer to a maximum of about 1600 pC/l by the end of Sept. Then the value showed a rapid decline. The Cs^{137} body burden was studied in persons from Masfjorden, which has a high yearly precipitation, and also from Bergen. Large differences in the body burdens measured in the two groups were found, Masfjorden being the highest, despite the fact that the towns are not more than 30 miles apart. No evidence of a direct correlation between milk consumption and the Cs^{137} body-burden was found. (P.C.H.)

1362 STRONTIUM-90 PLASMA LEVELS AND EXCRETIONS IN YOUNG ADULTS ON A LOW CALCIUM DIET. Joseph Samachson and Herta Spencer-Laszlo (Veterans Administration Hospital, Hines, Ill.). Nature, 200: 593-4 (Nov. 9, 1963).

Strontium-90 plasma levels and excretions were studied in young adults fed on a constant diet of 1.1 g of Ca and 13.4 μμc Sr^{90} a day. The average daily intake during 3 periods of 6 days each was 179 mg Ca and 3.3 μμc Sr^{90}. Calculations from food were made on the assumption that 20% of the dietary Sr^{90} was absorbed. It was found that the average urinary excretion of Sr^{90} calculated from the intake of Sr^{90} was about 60% of that found, and the average Sr^{90} plasma level calculated from food was 60% of the average levels calculated from the urine. This suggests that approximately 40% of the Sr^{90} levels and urinary excretions during the studies was due to previous intake of Sr^{90}. The results were compared with previous data in which the Ca and Sr^{90} were ingested with milk. (P.C.H.)

1363 THE ANALYSIS OF RADIOISOTOPE CLEARANCE DATA OBTAINED USING BONE SEEKING ISOTOPES. H. I. Glass (Western Regional Hospital, Glasgow) and B. E. C. Nordin. Phys. Med. Biol., 8: 387-97(Nov. 1963).

A method of calculating bone formation rate is described, based on a general catenary model. A detailed analysis of the model, when reduced to two exchanging compartments, is presented. Biologically acceptable values of bone formation rate are calculated from the data obtained using calcium-45. Optimum use of the data is achieved by utilizing a computer program which can fit multi-exponential curves to the data. (auth)

1364 PLACENTAL TRANSFER OF STRONTIUM IN RATS. A. G. Ruhmann, B. J. Stover, K. R. Brizzee, and D. R. Atherton (Univ. of Utah, Salt Lake City). Radiation Res., 20: 484-92(Nov. 1963).

Various subcutaneous doses of Sr^{85} and Sr^{90} were given to adult female rats, some of which were pregnant. Analysis of fetuses from the pregnant rats revealed that gestational injection day was the most important factor governing fetal retention of Sr received through the placenta. Litters from dams injected on the nineteenth gestational day contained an average of three times the fractional dose of those injected on day 17, and 16 times that of those injected on day 15. Young rats showed a continued increase in Sr burden from birth until weaning. There was a marked disparity in Sr metabolism between pregnant and nonpregnant rats. The dams retained less Sr and excreted larger quantities through the kidneys than did their nonpregnant counterparts. (auth)

1365 PRENATAL AND POSTNATAL TRANSFER OF ZINC-65. Samuel A. Gunn, Thelma Clark Gould, and W. A. D. Anderson (Univ. of Miami, Coral Gables, Fla.). Radiation Res., 20: 504-9(Nov. 1963).

Rodent progeny may be born with radioactive Zn, even if the only source of Zn^{65} is the male sire. Once the female is contaminated, there is ready transfer to the progeny prenatally via the placenta and postnatally via lactation. Zinc-65 content of the progeny may be lessened by giving the radioactive pups a nonradioactive foster mother; however, because of the slow rate of excretion of Zn^{65} by the young, more than 50% of the radioactivity detectable at birth is still present at 36 days of age. (auth)

1366 RARE EARTHS AND RUTHENIUM: METABOLISM AND REMOVAL FROM THE MAMMALIAN BODY. A. Catsch and D. Seidl (Kernforschungszentrum, Karlsruhe, Ger.). p.191-205 of "Diagnosis and Treatment of Radioactive Poisoning." Vienna, International Atomic Energy Agency, 1963. (KFK 171)

The effectiveness of a chelating agent in removing an internally deposited radiometal is essentially determined by: its affinity toward the radiometal as related to the competition of endogenous cations and ligands; the velocity by which the exchange reaction between therapeutic and endogenous ligands proceeds. The limitation of the therapeutic effect due to the last mentioned factor is exemplified by experimental data with radioruthenium. Although the chelation of ruthenium by several compounds, particularly the 2:2'-bis[di(carboxymethyl)aminoethylthio] ethane, ex-

ceeds markedly the binding affinity of proteins, the mobilized fraction is small because of the extremely sluggish dissociation of the ruthenium-protein complexes. On the other hand, a very high mobilization of radiocerium is guaranteed by its fast co-ordination reactions, provided that suitable chelators are chosen. Structural factors determining the relative chelate stability are discussed. Ligands with a pronounced polydentate structure, e.g., diethylenetriaminepentaacetic acid and triethylenetetraaminehexaacetic acid, proved to be most effective. Experimental data are presented allowing one to work out the optimal dosage schedule which is the parenteral administration of only a few medium doses, separated by several treatment-free days. (auth)

1367 AN EXPERIMENTAL ANALYSIS OF THE SPECIFICITY OF ACTIVELY ACQUIRED TOLERANCE IN MICE. G. Doria (Euratom, Geneva). 7p. (CONF-239-1; EUR 361e)

From International Symposium on Homotransplantation, Padua, Italy, May 1963.

Tolerance to CBA skin was induced in C3H mice by neonatal injection of CBA spleen cells. When two months old, the C3H recipients were grafted with CBA skin. These skin grafts showed no signs of rejection during the observation time of three months, whereas CBA skins grafted onto C3H mice non injected at birth showed complete necrosis in 11.7 days. Normal C3H and C3H mice tolerant to CBA skin were injected with rat RBC and sacrificed 12 days later for serum titration of anti-rat RBC agglutinins. The agglutinin titer was the same in both groups. This indicates that the unresponsiveness of C3H mice to CBA skin was specific, for the tolerant mice were able to respond with normal vigor to antigens (rat RBC) unrelated to C3H and CBA. Whether this response was due to the host immune system or to the CBA spleen cells which may have colonized the C3H newborns was subsequently investigated. Spleen cells from tolerant C3H mice sensitized to rat RBC were injected into two groups of lethally irradiated recipients: C3H mice preimmunized against CBA and CBA mice preimmunized against C3H. Both groups were given rat RBC immediately after the spleen cell transfer from the tolerant mice and sacrified a week later for serum titration of anti-rat RBC agglutinins. These agglutinins, due to the secondary response of the transferred spleen cells, could be detected only in the group of C3H recipients preimmunized against CBA. This shows that anti-rat RBC agglutinins in tolerant mice were produced by the immune system of the C3H host. The theoretical implications of this finding are discussed. (auth)

Radiation Effects

1368 (BNL-6893) EFFECTS OF CHRONIC GAMMA RADIATION ON SEED PRODUCTION IN AN OAK FOREST. G. R. Stairs (Yale Univ., New Haven. School of Forestry and Brookhaven National Lab., Upton, N. Y.). [1963]. Contract AT(30-1)-2755. 34p.

Radiosensitivity of seed production was investigated in Quercus trees growing under conditions of chronic gamma radiation. Evaluation of radiation damage was made from observations on floral structures, embryogenesis, and the growth of progeny obtained from seed. The study conditions included trees that had been irradiated for only a few months and also those that were chronically irradiated for a number of years. Embryo enlargement was completely inhibited at an early stage on trees exposed to 45r/day; at radiation intensities above 45r/day both vegetative and reproductive development were completely suppressed. At an exposure of 25r/day seed was obtained from parent trees that had been irradiated for 10 months. The seed produced at this level was low in germinative capacity and few of the seedlings survived. Trees produced seed following several years of chronic radiation exposure at levels below 15r/day. There were visual aberrations in floral morphology and internal abnormalities of acorns in trees that had received low level chronic irradiation for a period of years. Survival percentages and height growth of seedlings from these trees decreased with increasing radiation levels. The frequency of aberrations in embryo development increased at the higher levels of radiation, but were sporadic in appearance. It is suggested that many of the radiation damaged acorns abscised from the tree and thus escaped detection. (auth)

1369 (BNL-6894) CHRONIC AND ACUTE RADIATION OF MICROSPOROGENESIS AND MATURE POLLEN IN QUERCUS. G. R. Stairs (Yale Univ., New Haven. School of Forestry and Brookhaven National Lab., Upton, N. Y.). [1963]. Contract AT(30-1)-2755. 42p.

The production of pollen under conditions of chronic gamma irradiation was investigated for three oak species. Two chronically irradiated areas were studied: a low level (1 to 15r/day) area where trees had received varying amounts of radiation over a period of 11 years, and a second area receiving gamma radiation for about five months previous to the investigation. In the latter study dose levels ranged from lethal (45r/day) to a region of no detectable effect. In both areas pollen abortion showed a significant increase with increasing radiation exposure, although germinable pollen was produced at all survival levels examined. The germinating pollen tube length did not show a significant decrease in the irradiated material examined. In addition to cytological effects there was a marked delay in floral phenology for both areas. Acute irradiation of male flower buds at different stages of meiosis, and of mature pollen were reported. The radiosensitivity of microsporogenesis was evaluated by cytological scoring at anaphase I, and by pollen abortion, germination, and tube length. Both the number of chromosome fragments/100 cells scored at anaphase I and pollen abortion showed a linear increase with an increase in radiation exposure. Pollen germination and tube length were less effected by radiation (based on a percent of unaborted grains). It was suggested that a range of 1 kr to 4 kr will be appropriate for irradiating male flower buds of oak to be utilized in a mutation breeding program. Contingent upon additional studies the range of radiation recommended for flower buds is also suggested for the induction of mutations in pollen. Pollen was found to be highly resistant to radiation when evaluated by germination and tube growth studies. No effect was found with irradiation of 100 kr; at 300 kr both germination and tube lengths were depressed. At these levels it is probable that germination is an expression of cytoplasmic growth and not of nuclear viability. No significant difference was found between responses of the two species for either chronic or acute irradiation. (auth)

1370 (BNL-6900) THE STIMULATION OF PLANT GROWTH BY IONIZING RADIATION. Karl Sax (Brookhaven National Lab., Upton, N. Y.). [1963]. Contract AT(30-2)-Gen-16. 22p.

The stimulation of plant growth by exposing seeds or growing plants to low doses of ionizing radiation, or by the use of radioactive fertilizers, was reported by many in-

vestigators during the past 65 years. There is critical evidence that ionizing radiation may stimulate plant growth at certain stages of development and may induce earlier flowering. It can also stimulate lateral bud development, presumably by auxin inactivation. These stimulating effects are usually of small magnitude and are often not reproducible, although in individual tests the differences may be statistically significant. The evidence for increased yields of crop plants is less conclusive. Large increases in yields of crop plants by irradiating seed, soaking seed in radioactive solutions, or by the use of radioactive fertilizers were reported from the USSR. Similar tests in the U. S. have given only negative results. (auth)

1371 (BNL-7343) THE EFFECTS OF 2.0-Bev PROTONS IN MICE. John E. Jesseph, William H. Moore, Victor P. Bond, and Stuart W. Lippincott (Brookhaven National Lab., Upton, N. Y.). [1962]. Contract AT-30-2-GEN-16. 16p. (CONF-205-9)

From International Atomic Energy Agency Symposium on the Biological Effects of Neutron Irradiations, Upton, N. Y., Oct. 1963.

The biological effects of proton beams of 2.0 to 2.2 Bev were studied in mice. Physical studies of particle distribution and depth dosimetry are described. Data are presented on lethal dosage measurements and studies of light element activation in tissues through proton reactions (p,pn) as determined by whole-body counting of γ activity. (C.H.)

1372 (BNL-7359) PROGRESSIVE EPITHELIAL DYSPLASIA IN MOUSE SKIN IRRADIATED WITH 10 Mev PROTONS. Stuart W. Lippincott, John E. Jesseph, Wenceslao G. Calvo, and Charles P. Baker (Brookhaven National Lab., Upton, N. Y. and Wake Forest Coll., Winston-Salem, N. C.). [1961]. Contract AT(30-2)-Gen-16. 15p. (CONF-205-8)

From International Atomic Energy Agency Symposium on the Biological Effects of Neutron Irradiations, Upton, N. Y., Oct. 1963.

Up to 6 months after proton irradiation at 600 and 1200 rad epithelial hyperplasia persisted in the exposed mouse skin. Hydropic degeneration of many epithelial cells occurred with intra-epithelial cyst formation with hemorrhage. Focal areas of basement membrane degenerated. Interruption of and fragmentation of underlying collagen fibers was prominent. Of interest is the paramount observation that with this degree of cellular alteration and with complete breakdown of basement membrane the epithelial cells did not invade into the dermis. This suggests that the altered epithelial cells must actually be definitely neoplastic for true invasion to occur and that a single exposure at these doses did not alter the cells sufficiently to render then anaplastic. It is possible however that larger single doses with subsequent time interval elapse might provoke the formation of neoplastic cells. This and the effect of repeated small doses and with longer periods after irradiation before sacrifice of the animal are now being investigated. (auth)

1373 (BNL-7360) USE OF NEUTRON IRRADIATIONS IN THE BROOKHAVEN MUTATIONS PROGRAM. J. P. Miksche and S. Shapiro (Brookhaven National Lab., Upton, N. Y.). [1963]. Contract AT(30-2)-Gen-16. 23p. (CONF-205-7)

From International Atomic Energy Agency Symposium on the Biological Effects of Neutron Irradiations, Upton, N. Y., Oct. 1963.

Many plant species were irradiated with x rays, thermal and fast neutrons, and γ radiation during the past 10 yr of the cooperative mutations program and adjunct mutation breeding program. Four major concepts and/or approaches related to the use of mutagenic agents in plant breeding that have evolved are discussed. It was concluded that outcrossing between treated and nontreated populations must be reckoned with, and consequently the two populations should be separated before a true measure of mutation induction can be ascertained; chromosome rearrangement studies are useful, with particular emphasis on inducing disease resistance; work concerned with tissue reorganization and rearrangement as related to chimera production and basic understanding of tissue ontogeny, particularly with fruit crops and horticultural crops is promising; and the effectiveness of responses of plant tissues to neutrons and other mutagenic agents is extremely variable and more basic work is needed before the full potentialities of mutation breeding as a tool in crop improvement can be appreciated. (auth)

1374 (BNL-7367) RBE OF MONOENERGETIC FAST NEUTRONS: CYTOGENETIC EFFECTS IN MAIZE. H. H. Smith, J. L. Bateman, H. Quastler, and H. H. Rossi (Brookhaven National Lab., Upton, N. Y.). [1963]. Contract AT(30-2)-Gen-16. 27p. (CONF-205-6)

From International Atomic Energy Agency Symposium on the Biological Effects of Neutron Irradiations, Upton, N. Y., Oct. 1963.

The relative biological effectiveness (RBE) of neutrons of 5 energies and x radiation at 3 exposure levels were compared in maize seeds. The maize material used in these experiments had the advantage for RBE studies of yielding a basically first order dose-response curve ($Y = \alpha + \beta D$) with low (x rays) as well as with high (fast neutron) LET radiations. The frequency of yellow-green ($\underline{yg_2}$) sectors in leaves, 3, 4, and 5 of young plants grown from irradiated $\underline{Yg_2}/\underline{Yg_2}$ seeds served as a quantitative measure of response. The mutant sectors are believed to be due mostly to simple chromosome breakage and deletion. An exposure apparatus was used which produced essentially equal dose rates in five rings of seeds placed so as to intercept neutrons of 0.43, 0.65, 1.00, 1.50, and 1.80 Mev. Dose average LET values for these energies are 72, 67, 58, 57.5, and 42.5 kev/μ, respectively. Two experiments were performed at dosages that gave responses which were linear, below saturation levels, and overlapping in range for x rays and neutrons. These ranges in dosages were 32.8 to 126.4 rads of neutrons and 1500 to 15,600 rads of 250 kvp x rays. RBE values, calculated from relative slopes of linear regression lines for N and X, ranged from 42 to 135. Monoenergetic fast neutrons of 0.43 Mev were the most efficient in producing $\underline{yg_2}$ sectors as shown by the yield of sectors per krad and highest RBE values. The RBE values obtained in these experiments are higher than commonly reported. With regard to minimum permissible levels of radiation, these results suggest the alternatives that either chromosome breaks in plants have a much higher RBE than comparable reactions in man and need not be considered; or that the problem of chromosome damage per se in human tissues be reexamined after exposure to high LET radiations and/or low LET radiations at low doses or dose rates. (auth)

1375 (BNL-7371) LENS OPACIFICATION IN MICE EXPOSED TO MONOENERGETIC FAST NEUTRONS. J. L. Bateman, V. P. Bond, and H. H. Rossi (Brookhaven National Lab., Upton, N. Y. and Columbia Univ., New York). [Sept. 20, 1963]. Contract AT(30-2)-Gen-16. 30p. (SM-44/18; CONF-205-5)

From International Atomic Energy Agency Symposium on the Biological Effects of Neutron Irradiations, Upton, N. Y., Oct. 1963.

The degree of lens opacification was studied as a function of age and time following exposure of mice to low and fractionated doses of monoenergetic fast neutrons, x radiation, and γ radiation. A slit-lamp microscope was employed for visualization of the lens in the immobilized head of the mouse after the irises were dilated with 1% homatropine. The technique of lens examination is described and illustrated. Data collected at 26 weeks posttreatment indicate that 0.43-Mev neutrons are slightly more effective than those of 1.80 Mev, and that both are about 10 times as effective as 250-kvp x rays in the dose range covered. Lethality was greatest in the 0 to 1 week groups, with loss of all animals exposed to 800 rads of Co^{60} γ radiation, while most of the animals exposed to this dose at 5 weeks of age survived. Initial damage site and recovery of the irradiated lens are discussed. (C.H.)

1376 (TID-19516) A COMPARISON OF X-RAY AND ULTRAVIOLET INDUCED ABERRATIONS IN POLLEN TUBE CHROMOSOMES OF TRADESCANTIA. Final Report. Paul C. Bailey (Alabama Coll., Montevallo). Aug. 15, 1963. Contract AT(40-1)-2856. 16p.

Aberrations induced by x radiation and ultraviolet radiation in pollen tube chromosomes of Tradescantia were compared. Data are presented on dose curve responses to varying moisture conditions and the influence of a protein synthesis inhibitor on the radioinduced aberrations. Tentative data indicate that the breaks resulting from the two types of radiation are located at different points along the length of the chromosome. (C.H.)

1377 (TID-19655) COMPARATIVE STUDIES OF THE EFFECTS OF X-RADIATION ON MAMMALS AND PROTOZOA. Progress Report, November 1, 1962–September 1, 1963. Jay S. Roth (Connecticut. Univ., Storrs). Contract AT(30-1)-2737. 35p.

Progress is reported in studies of the effects of radiation on cellular enzyme levels in rat tissues after whole-body exposure. A micro method was developed for the determination of deaminase activity and results are reported from applications in studies of the effects of γ radiation on deaminase activity in rat spleen and thymus. An assay method for desoxyribonuclease inhibitor was developed and applied in studies of some properties of this enzyme in rats. Data are also included from preliminary studies on the effect of ionizing radiation on desoxycytidylate deaminase in rapidly proliferating tissues; studies on thymidylate phosphatase, thymidine kinase, and thymidylate kinase activities in transplantable rat hepatomas; and preliminary studies on the effect of whole-body irradiation on thymidine kinase activity in hepatomas. (C.H.)

1378 (CEA-tr-X-490) DEVELOPPEMENT VEGETATIF ET MATURITE SEXUELLE CHEZ DES PLANTES ISSUES DE GRAINES IRRADIEES AUX RAYONS X. (Vegetative Development and Sexual Maturity in the Case of Plants from Seeds Irradiated with X Rays). P. Messeri. Translated into French from Nuova Giorn. Botan. Ital., 44: 261-5(1957). 14p.

The first results obtained in a study on the effect of x rays on the complex phenomenon of vegetative growth in Lactuca sativa, Spinacia oleracea, Pisum sativum, and Vicia faba are reported. Dry seeds were exposed to a single dose of 600, 1200, and 1800 r, and seeds soaked in water for 24 hr were exposed to 1800 r. In Lactuca sativa no perceptible difference of the germinative power was found between the grains irradiated at different doses, dry or wet. A sharp difference was evident in the germination power of Spinacia oleracea, but no precise evaluation was possible. Soaking the seeds has a great effect on the germination period. Low doses seem to improve the prematureness of germination and the plant growth, but doses of 1800 r seem to have an inhibiting effect on these two phenomena. Radiation does not affect the germinating power in Pisum sativum, but the effect of water is very clear, increasing both the speed of initial development and the development to maturity. In Vicia faba the independent action of water as a stimulating factor is evident. These results are discussed and compared with previous studies. (J.S.R.)

1379 (FTD-TT-63-558) A CASE OF ACUTE RADIATION SICKNESS IN MAN. O. G. Alekseeva, A. F. Bibikova, et al. Translation of "Sluchai Ostroi Luchevoi Bolezni u Cheloveka" (a publication of State Publishing House of Medical Literature, Moscow, 1962). 168p.

The case history is described of a fatal case of radiation sickness in a 19-yr-old, single research worker who carried a Cs^{137} capsule with an activity equivalent to 10 g of Ra for 20 hr with the intention of committing suicide. The patient died on the 18th day after irradiation. Detailed data are included on dosimetry, hematological changes, bone marrow changes, and changes in biochemical indices and bacterial flora of the mouth and intestine during the course of the acute radiation syndrome. Pathological data obtained at autopsy are included. (C.H.)

1380 (OTS-62-11069(No.3)) ARCHIVES OF IMMUNOLOGY AND EXPERIMENTAL THERAPY. Translated Reprint of Archiwum Immunologii i Terapii Doswaidczalnej, 10: No. 3, 1962. 329p.

Separate abstracts were prepared on 3 articles in this journal. Other articles in the journal cover various aspects of immune reactions. (C.H.)

For abstracts of individual papers see: 1381, 1382, and 1383.

1381 (OTS-62-11069(No.3)(p.768-80)) MORPHOLOGICAL AND HISTOCHEMICAL CHANGES IN THE CEREBRAL NERVE CELLS OF RABBITS PRODUCED BY IRRADIATION WITH SMALL DOSES OF X-RAYS. I. MORPHOLOGICAL CHANGES. Jozef Tarmas. Translated from Arch. Immunol. Terapii Doswiadczalnej, 10: No. 3, 1962.

In rabbits irradiated with single doses of 25 or 50 r of x rays to the whole body, morphological alterations were not observed in the cerebral nerve cells up to 16th day after irradiation. A single dose of x rays of 100, 150, or 200 r caused enlargement of the cells, nuclei and nucleoli, various types of tigrolysis, and moderate vacuolization of the cytoplasm, depending on the dosage. These alterations were observed usually in individual cells of the different centers of gray substance of the brain, especially, however, in the cells of the nuclei associated with the functions of the autonomous nervous system. (auth)

1382 (OTS-62-11069(No.3)(p.781-96)) MORPHOLOGICAL AND HISTOCHEMICAL CHANGES IN THE CEREBRAL NERVE CELLS OF RABBITS PRODUCED BY IRRADIATION WITH SMALL DOSES OF X-RAYS. II. NUCLEIC ACIDS. Jozef Tarmas. Translated from Arch. Immunol. Terapii Doswiadczalnej, 10: No. 3, 1962.

In the cerebral nerve cells of rabbits irradiated with a single dose of 150 and 200 r of x rays applied to the whole body discrete changes in the distribution of desoxyribonu-

cleic acid in the cell nuclei take place, indicating possible changes in its metabolism. Doses of 25, 50, and 100 r appear to be without any appreciable effect on DNA. X rays in doses of 50, 100, 150, or 200 r elicit changes in the intensity and distribution of the reaction of RNA cerebral nerve cells, increasing during 4 to 6 days after the irradiation and proportional to the size of the dose. Doses of 50 to 150 r of x rays are mostly found to lead to increased reaction to RNA in the nucleolus and cytoplasm, and doses of 150 to 200 r to diminish intensity of the reaction. Changes in the distribution of DNA and in the content and distribution of RNA occur mainly in the nerve cells of the nuclei of the brain stem, chiefly and more frequently, however, in the cells of those nuclei whose function is connected with the autonomous nervous system. (auth)

1383 (OTS-62-11069(No.3)(p.797-808)) MORPHOLOGICAL AND HISTOCHEMICAL CHANGES IN THE CEREBRAL NERVE CELLS OF RABBITS PRODUCED BY IRRADIATION WITH SMALL DOSES OF X-RAYS. III. GLYCOGEN. Jozef Tarmas. Translated from Arch. Immunol. Terapii Doswiadczalnej, 10: No. 3, 1962.

In rabbits irradiated with a single dose of 25 to 200 r of x rays applied to the whole body, the glycogen content of cerebral nerve cells was diminished proportionally to the size of the irradiating dose. The diminished glycogen content in nerve cells occurs four days after irradiation with doses of 25 to 200 r; in animals irradiated with 150 to 200 r the effect persists up to 16th day. A pronounced diminished content of glycogen in perivascular astrocytes was observed after irradiation with 150 to 200 r. The drop in glycogen content is particularly distinct in the nerve cells of the nuclei of the brain stem associated with the functions of the autonomous nervous system, while the astrocytes in these nuclei still retain fairly high contents of glycogen. (auth)

1384 EXPERIMENTAL STUDIES ON SERUM AND LEUKOCYTE ALKALINE PHOSPHATASE IN WHITE RATS OF WHOLE BODY X-RAY IRRADIATION. Kenichi Nakagawa (Niigata Univ., Japan). Acta Med. Biol. (Niigata), 11: 41-56(Aug. 1963).

While the body is affected in various ways by x rays, effects especially on the hematopoietic organs and peripheral blood are intense. These effects are the subjects of reports presented by almost countless workers. But, relatively few are the papers on the effect of x rays on alkaline phosphatase. Though basic experiments have been made with serum plasma, leukocyte and various organs, methods differ and many questions are not fully answered yet. The effects of x rays on serum alkaline phosphatase activity, leukocyte positivity rate for alkaline phosphatase, and its positive degree are described. Taken up also in the behavior of alkaline phosphatase when leukocytes have been increased by Cepharanthin. (auth)

1385 THE EFFECT OF X-IRRADIATION ON THE ACTIVATION OF AMINO ACIDS IN NUCLEI FROM RAT THYMUS GLAND. J. A. Smit and L. A. Stocken (Oxford Univ.). Biochem. J., 89: 37-44(Oct. 1963).

Amino acid-activating enzymes were extracted with an ionic medium from nuclei prepared in iso-osmotic sucrose. Pyrophosphatase activity was found in this enzyme preparation. Amino acyl hydroxamate formation was measured spectrophotometrically and also by isotopic methods that have the advantage of greater sensitivity. An electrophoretic isotopic method was used to study the activation of acidic, basic and neutral amino acids. Amino acyl hydroxamate formation is critically dependent on the concentration of amino acids present. The activation of eight amino acids was demonstrated. Activating enzymes extracted from nuclei x-irradiated in vitro had a decreased activating ability, but irradiation of the isolated activating enzymes caused no inhibition. (auth)

1386 ON THE EARLY ONSET OF THYMINELESS DEATH OCCURRING AFTER EXPOSURE TO ULTRAVIOLET LIGHT. Ronald E. Rasmussen and Robert B. Painter (Ames Research Center, Moffett Field, Calif.). Biochim. Biophys. Acta, 76: 157-9(Sept. 17, 1963).

The onset of thymineless death occurring after exposure to ultraviolet light was studied in Escherichia coli strain B-3. Cultures twice subcultured in minimal medium containing 1 mg/ml glucose and 5 μg/ml thymidine were diluted with a minimal salt solution and exposed in 10-cm petri dishes to 2537 Å radiation from a low-pressure mercury are at a dose rate of about 5 ergs/mm^2/sec. One-ml samples of the irradiated suspension were transferred to flasks containing 99 ml of the minimal salt solution with thymidine or glucose. One set of plated samples was photoreactivated for 15 min. Results indicate that ultraviolet-light lesions contributing to the early onset of thymineless death may be partially photoreactivated. It may therefore be concluded that thymine dimer is involved in producing early thymine death. Under the experimental conditions used, effects of ultraviolet light were heterogeneous. Early death was found to be reversible through the presence of thymidine. However, later death can only be prevented by thymidine, and the lag before onset is unaffected by photoreactivation. (H.M.G.)

1387 ULTRAVIOLET MICROSPECTROMETRIC INVESTIGATION OF PARTIALLY IRRADIATED PLANT CELLS. H. Glubrecht (Technische Hochschule, Hanover). Biophysik, 1: 78-86(1963). (In German)

Cells of the upper epidermis of Allium cepa were irradiated either in cell nuclei or in the cytoplasm with small beam bundles of uv of various spectral composition. The effect of the irradiation was analyzed using a uv microspectrometer. It is shown that in this manner even the effect of small radiation doses could be detected by modification of the extinction in the uv region. The most important result was that irradiation in the cell nuclei leads to modifications in the cytoplasm and irradiation of the cytoplasm leads to alterations in the cell nucleus. (tr-auth)

1388 EFFECTS FROM IRRADIATION OF RICE SEED WITH GAMMA RAYS AND NEUTRONS ON SEVERAL CHARACTERISTICS OF THE R_1 GENERATION. Birdie Yeh and M. T. Henderson (Louisiana Agricultural Experiment Station). Botan. Bull. Acad. Sinica (Taiwan), 4: 90-102(July 1963).

An investigation of radiation effects on a dormant seed variety of Nato, a variety of cultivated rice, was made using Co^{60} gamma rays and neutrons. Seed lots were exposed to 15, 20, 25, 30, 35, 40, and 50 Kr of gamma radiation or to neutrons for ¼, ½, 1, 2, 3, and 4 hours at a flux rate of 1.4×10^{12} thermal neutrons and 7.9×10^{10} fast neutrons per cm^2 per hour. Shortly after irradiation, seeds were planted in flats, and seedlings were transplanted to the field about three weeks after sowing. All doses of gamma rays ranging from 15 to 50 Kr caused measureable reductions in survival of R_1 plants. The reduction with increasing dosage was linear, with a drop of about 10% for each increase of 10 Kr. Dormant seed of rice proved highly sensitive to neutron radiation. Consequently, neutron radiation cannot be recommended for induction of mutations in

rice. All treatments of both gamma rays and neutrons caused marked reductions in fertility. However, the dosage-fertility curve was not linear for gamma rays as there was a distinct tendency for fertility to reach a minimum and level off before the highest dosage was reached. The same so-called saturation effect was found for the gamma ray treatments on frequency of translocations. The translocation frequency reached a maximum at about 35–40 Kr and did not increase further from 50 Kr. Several lines of evidence indicated that damage to R_1 plants by irradiation of dormant seed was not caused primarily by chromosome breakage. Because of major differences in results obtained here with rice and those reported with barley, it is apparent that general conclusions concerning response of various economic plants to irradiation of dormant seed cannot be drawn from research with a single or a few species. Due to a relatively high frequency of rings of 6 chromosomes compared to 2 rings of 4 chromosomes, it was concluded that certain of the 12 pairs of rice chromosomes undergo breakage much more frequently than do others. The results indicated that gamma ray dosages of 40–50 Kr can be utilized with dormant seed of rice, provided the moisture content of the seed is within the range 13–15%. (auth)

1389 SOME CHARACTERISTICS OF THE SURVIVAL CURVE OF CRYPT CELLS OF THE SMALL INTESTINE OF THE MOUSE DEDUCED AFTER WHOLE BODY X IRRADIATION. S. Hornsey (Medical Research Council, London) and S. Vatistas. Brit. J. Radiol., 36: 795-800(Nov. 1963).

The dose required to kill mice three to four days after whole body x irradiation is compared after single and after fractionated doses. It is assumed that death at three to four days after irradiation is due to the reduction of the crypt cells of the small intestine to a constant, though unknown, survival level. The difference in the dose required to produce this effect after single or fractionated doses gives a measure of the size of the shoulder on a Type C survival curve. The results suggest that the shoulder of the survival curve for the crypt cells of Leiberkühn is large, with D_Q more than 400 r and n more than 28. (auth)

1390 CYTOGENETICS OF SOME HAPLOID AND ANEUPLOID DERIVATIVES OF TRITICUM AESTIVUM. A. T. Natarajan, M. Ray, and M. S. Swaminathan (Indian Agricultural Research Inst., New Delhi, India). Caryologia, 14: 349-73(Sept.-Dec. 1961).

Radiation treatment of inflorescences of the wheat variety N.P. 809 just prior to the onset of meiosis gave rise to several haploids (2n = 21) in the progeny. When the inflorescences were given a subsequent dose of x rays after the emergence of the ear, several twin seedlings and a triplet arose in the progeny. Meiosis was studied in the microsporocytes of three different haploid plants. At pachytene, a few bivalents revealed associations at specific knob like intercalary regions or at the distal ends. A maximum frequency of five bivalents was found in one haploid plant. Various types of secondary associations were found both among univalents and bivalents and the incidence of such associations was found to decrease with an increase in bivalent frequency. It is suggested from the behavior of the satellited univalents that all such associations arise from attractions in specific regions of the chromosomes. Multivalent associations were observed during meiosis in the twin and triplet plants. Nearly 50% of all the chromosomes formed multivalent associations in the triplet. The highest association observed was a decavalent; octavalents were frequent. The progenies of the haploids, twins and triplet had variable chromosome numbers and plant and ear characteristics. A high degree of karotype re-patterning occurs in them. A greater incidence of cytological and morphological changes was observed in the progeny of the triplet in comparison with those of the haploids. Most morphological abnormalities in bread wheat can be correlated with whole chromosome or segmental aneuploidy. (auth)

1391 EXPERIMENTAL PRODUCTION OF A NEW KARYOTYPE IN DELPHINIUM. H. K. Jain, K. N. Vasudevan, and S. L. Basak (Indian Agricultural Research Inst., New Delhi). Chromosoma, 14: 534-40(Oct. 1963).

A karyotype which is both viable and stable was obtained in Delphinium following x-ray induced chromosomal rearrangements. It shows, on the whole, greater symmetry than the parental karyotype although one of the chromosome pairs was reduced to a minute size. The meiotic sequence in the structural heterozygote and the isolation of the homozygote having the altered karyotype in its progeny are described. The structural rearrangement was found to be associated with a change in the growth habit of the plants, indicating a possible position effect. (auth)

1392 EFFECT OF X RAYS ON THE NUCLEAR MEMBRANE OF SPERMATOCYTES OF LEBISTES RETICULATUS R. ELECTRON MICROSCOPE STUDY. Ernest Follenius (Universitè, Strasbourg). Compt. Rend., 257: 1982-4 (Sept. 23, 1963). (In French)

Irradiation of the testicle of Lebistes reticulatus shows the effect of x rays on the nuclear membrane. This effect is manifested by an alteration of the reconstitution process of the nuclear membrane after meiotic divisions. (tr-auth)

1393 COMPARATIVE EFFECT OF X RAYS OF MEDIUM ENERGY AND OF SOFT X RAYS ON THE SURVIVAL RATE OF CHLORELLA PYRENOIDOSA CHICK. Roland Gilet, Simone Santier, and Aline Villeroux (Centre d'Études Nucléaires, Grenoble, France). Compt. Rend., 257: 1985-8(Sept. 23, 1963). (In French)

For the same absorbed energy per cell, soft x rays (spectrum maximum at 8 kev, and maximum energy at 30 kev) seem two times as efficient as x rays of medium energy (spectrum maximum at 58 kev, and maximum energy at 220 kev), measured on the survival rate of Chlorella pyrenoidosa after acute irradiation. Hypotheses and approximations are discussed. (tr-auth)

1394 CHROMATID-TYPE ABERRATIONS INDUCED BY X RAYS IN HUMAN LEUKOCYTE CULTURES. M. A. Bender and P. C. Gooch (Oak Ridge National Lab., Tenn.). Cytogenetics, 2: 107-16(1963).

Human peripheral leukocyte cultures 66 hours old were irradiated with x rays and fixed 6 hours later. The cells were scored for chromosomal aberrations. The aberrations seen were mainly of the chromatid type, and included all of the expected types. The average coefficient of breakage production for four experiments was 0.0031, or virtually the same as that found earlier (Bender and Gooch) for chromosome-type aberrations induced in the human leukocyte system. (auth)

1395 EFFECT OF ADRENAL HORMONES ON THE RADIATION SENSITIVITY OF CHROMOSOMES OF THE CORNEA EPITHELIAL CELLS. Yu. Ya. Kerkis and V. V. Logvinova (Inst. of Cytology and Genetics, Academy of Sciences, Siberian SSR). Dokl. Akad. Nauk SSSR, 152: 992-4(Oct. 1, 1963). (In Russian)

Chromosomal rearrangement in corneal cells was investigated in adrenalectomized mice exposed to 25, 50 or 100 r of x-rays. The formation of bridges and fragments in the chromosomes during anaphase and early telophase

was taken as the criterion of radiation damage. Bilateral adrenalectomy was performed in two steps, 24 hr apart, and sham-operated animals served as controls. The same frequency of rearrangements was found between normals and adrenalectomized mice (0.05 to 0.06%), and also between normal irradiated animals and sham-operated irradiated animals. The frequency of rearrangements increases with the irradiation dose, particularly in the adrenalectomized animals, eventually reaching a 200-fold value of the normal frequency. At every irradiation dose, adrenalectomy was found to increase the damaging effects of radiations on the chromosome structure by a factor of two. The relation between the increase in mitotic activity due to adrenalectomy and the increase in mitotic activity due to adrenalectomy and the increase in the frequency of chromosome rearrangements is discussed. Emphasis is given to the role played by the adrenal hormones on the radiosensitivity of the organisms. (TTT)

1396 ON THE INFLUENCING OF BREATHING BY WEAK X-RAY IRRADIATION OF THE MIDBRAIN. R. Pape, A. Harasta, and O. Pichler. Fortschr. Gebiete Roentgenstrahlen Nuklearmed., 99: 551-9(1963). (In German)

Irradiation of the midbrain with doses of 2 r resulted in changes in respiration in 29 out of 35 patients examined. The direction of the change depended on the initial condition of the patient, resulting either in an increased frequency and depth of respiration, i.e., in hyperventilation, or in an opposite type of response. Similarities between these changes and the respiration of the "nervous respiratory syndrome" were observed. This suggests diencephalic and hypothalamic origins for these alterations in respiration. The difference in respiration before and after radiation is statistically highly significant and this is thought to prove the effectiveness of the radiation dose employed. (auth)

1397 TIME-SEQUENCE OF RECOVERY OF IRRADIATED ESCHERICHIA COLI. Luis V. Orce and Rita Lumi (Comisión Nacional de Energia Atómica, Buenos Aires). J. Bacteriol., 86: 1137-8(Nov. 1963).

An attempt was made to determine the sequence of the radiation repair event in bacteria. Stationary-phase cultures of E. coli B/r (CSH) were given 30,000 rad x-ray doses and filtered onto cellulose plastic membranes, which were then placed either on M-9 minimal medium or M-9 supplemented with 1% peptone. After time intervals of 30 seconds and 1, 5, 10, 20, 30, 45, 60, 120, 240, and 360 minutes, the filters were washed and transferred to minimal medium. In a second series the same procedure was followed except that the media used after washing were the reverse of that used before. Results yielded the conclusion that active repair occurs when environmental factors are favorable, but is delayed under unfavorable conditions. (H.M.G.)

1398 DIFFERENTIAL SENSITIVITY OF THE CELL LIFE CYCLE. J. Cellular Comp. Physiol., 62: Suppl. 1, 141-56(Oct. 1963).

A round-table discussion on the differential sensitivity of the cell life cycle is presented. Particular topics discussed were: reproductive survival of HeLa S3 x irradiated cells at different stages of the division cycle, concept of the cell cycle, variation of rate of synthesis of DNA during S phase of L cells and effect of uv on DNA synthesis, effects of x rays and nitrogen mustard on DNA synthesis and mitosis, and Tetrahymena cells in the G2 phase-sensitivity to temperature and to inhibitors of protein synthesis. (H.M.G.)

1399 SEX AND RADIATION AS FACTORS IN PERIPHERAL CUE DISCRIMINATION LEARNING. A. A. McDowell and W. Lynn Brown (Univ. of Texas, Austin). J. Genet. Psychol., 102: 261-5(June 1963).

Tests were made on 64 rhesus monkeys, ranging in age from 40 to 52 months, which had been exposed to nuclear radiation (273-670 rem) at the Nevada Test Site ~28 months before the present study. This investigation sought to determine if monkeys with less training on direct response to the relevant cue, and younger than the subjects previously used, could resolve a peripheral cue, color discrimination problem. Secondly, in view of previously reported radiation and sex differences in scope of attention, the investigation sought to explore these two parameters with respect to this learning paradigm. All monkeys had previously experienced preliminary Wisconsin General Test Apparatus (WGTA) training, testing on reduced-cue discrimination and delayed response problems, and testing on a series of dot discrimination problems. All training was conducted in a modified version of the WGTA. The practice effect was significant indicating that rhesus monkeys, if given extended training, can learn color discrimination when the discriminanda are displaced in the horizontal-parallel dimension for a distance of 7.875 in. from the site of reward. The radiation-groups-by-sex-by-practice interaction was significant: for the females, radiation exposure slowed the rate of improvement with practice; for the males, the converse was true. While the disparity between these results and the earlier results cannot be adequately resolved in the context of the present experiment, such a disparity may reflect differences in the training histories of the subjects involved in the two studies. Thus, extensive training to respond directly in the contiguous cue-reward situation may reduce response tendencies to peripheral stimuli. The finding of a significant radiation-groups-by-sex-by-practice interaction suggests that exposure to radiation affects the sexes differently; previous research, however, has shown that radiation exposure decreases the distractibility of the monkey with a consequent narrowing of attention and that female monkeys show greater focalization of attention than do male monkeys. In view of this previous research, the significant triple interaction can be interpreted as reflecting a radiation-induced narrowing of attention for both sexes. Because of the sex differences in attention in normal monkeys, however, the result of this induced narrowing of attention for the males may be proportionately greater exclusion of irrelevant (peripheral) stimuli whereas, for the females, the narrowing must involve, to a greater extent, the relevant (proximal) stimuli. (BBB)

1400 THE EFFECTS OF GAMMA RADIATION AND APHOLATE ON THE REPRODUCTIVE TISSUES OF DROSOPHILA MELANOGASTER MEIGEN. George E. Cantwell and T. J. Henneberry (Dept. of Agriculture, Beltsville, Md.). J. Insect Pathol., 5: 251-64(June 1963).

Adult flies were treated with apholate or γ rays to determine their effects on reproductive tissues. Male and female flies 3 to 4 days old were exposed to 8 or 16 Kr of Co^{60} radiation at a rate of ~320 r/min or were fed 0.25 or 1% apholate in the diet. Ovaries and testes were removed at daily intervals for microscopic examination. With the higher doses of either treatment, cessation of sperm production occurred in the anterior end of the testes after the 8th day, with a general necrosis of the germinal epithelium in that area. The necrosis progressed until the 19th day when few sperm were observed in the testes of treated males. The ovaries from treated females were

reduced in size, and with the high dose of each treatment this noticeable change occurred two days following treatment and became more prominent until the 10th day when very little ovarian tissue remained. Microscopic examination of Feulgen-treated ovarioles revealed very small Feulgen-positive clumps of chromatin, which indicated that complete breakdown of the nurse cells, oocytes, and follicle cells had occurred. Untreated females mated to males either fed 1% apholate or exposed to 16 Kr deposited a large number of eggs, none of which hatched. Since fertilization precludes egg laying in D. melanogaster, it was evident from the egg production data and microscopic examination that sperm transfer was not halted by the levels of either treatment used. Some adults emerged from eggs deposited by untreated females mated to males fed 0.25% apholate or exposed to 8-Kr radiation, indicating that the treatments caused development of a lethal factor in some of the sperm which fertilized eggs. No adults emerged from eggs fertilized by males treated with high doses of either treatment which induced lethality in all sperm which fertilized eggs. No eggs were deposited from females irradiated with 16 Kr and mated to untreated males and none were deposited after the 2nd day from females fed 1% apholate and mated to untreated males. No adults emerged from the few eggs deposited, corroborating the histopathological investigation, which showed pycnosis and Feulgen-positive chromatin clumps and ovarian atrophy soon after treatment. Females fed 0.25% apholate or exposed to 8 Kr and mated to untreated males produced few eggs but some adults emerged. (BBB)

1401 THE CROSS-RESISTANCE TO PENICILLIN AND RADIATION OF ESCHERICHIA COLI B. Vera Kutas. Magy. Radiol., 15: 303-9(Sept. 1963). (In Hungarian)

The radiosensitivity of cultures resistant to 1500 IU/ml, 2000 IU/ml, 2500 IU/ml of penicillin, produced from strain E. coli B was examined. Cultures in the log-phase were streaked in monocellular layers on the agar surface and x irradiation was applied. As a result of penicillin treatment cell filaments consisting of several members were formed. Measuring the effect of ionizing radiation by the percentage survival, the cultures resistant to penicillin proved to be considerably more radioresistant than the parent strain B, non-treated with penicillin. (auth)

1402 LATE INJURIES TO LUNGS 22 YEARS AFTER X-RAY SIEVE-IRRADIATION OF A SUPPOSED BRONCHIAL CARCINOMA. M. Loew and W. Nitsch (Otto-Fricke-Frankenhaus Paulinenberg, Bad Schwalbach, Ger.). Med. Klin. (Munich), No. 40, 1637-40(1963). (In German)

The case of a 66-year-old man, who died as a secondary consequence of intensive deep x-ray therapy of the right lung region after an unusually long time of 22 years, is described. In coincidence with the irradiated cutaneous field, a small, hard shrinkage the size of a fist in the bronchial tubes and a later-appearing bronchial pneumonia were found. The non-irradiated upper lobe was transformed with emphysematous blisters. The remaining lung showed a diffused, probably not radioinduced emphysema. Death occurred with the symptoms of heart failure due to respiratory insufficiency. (tr-auth)

1403 THE INFLUENCE OF PROTON AND GAMMA-EMISSIONS ON THE FUNCTIONAL STATE OF THE VESTIBULAR ANALYZER. A. A. Sveshnikov. Med. Radiol., 8: No. 9, 48-52(Sept. 1963). (In Russian)

The threshold sensitivity and reactivity of the vestibular analyzer of dogs was assessed on an electric rotating device, which enables a wide amplitude of angular accelerations and speeds to be obtained. The reaction of both labyrinths to caloric stimulation was also studied. Irradiation was by protons (energy of 510 Mev) in a dose of 500 and 350 rad and gamma rays in a single dose of 200 r and in fractional doses ~9 r per day, with a dose energy of 0.05 r/min. Changes of the vestibular analyzer (a diminution of the threshold sensitivity and reactivity) were most pronounced in disturbances of common compensatory mechanisms. The presence of levelling, paradoxical phases of inhibition, and a disturbance of reciprocal correlations in the activity of labyrinths in acute radiation sickness are disclosed. Upon investigation of vestibulovegetative reflexes an intensification of the parasympathetic effect was noted. (P.C.H.)

1404 AN INHIBITION OF ANTIBODY FORMATION IN MONKEYS IN LARGE DOSES OF GAMMA-IRRADIATION. S. M. Pekerman. Med. Radiol., 8: No. 9, 61-5 (Sept. 1963). (In Russian)

The conditions of irradiation ensuring a complete inhibition of the immunological reactivity in monkeys in connection with bone marrow transplantation were determined. 15 monkeys (Macaca rhesus), aged 2–3 years, were subjected to gamma irradiation in doses of 314, 407, 592, 714, and 814 r. 24 hours later these monkeys and 9 control monkeys were immunized with typhoid vaccine, sheep erythrocytes, egg yolk, or horse serum. Doses of 315 and 407 r did not inhibit the immunological reactivity, while doses of 592 and 714 r caused a considerable inhibition of the latter, manifested by a reduction of the titers of antibodies and their delayed formation. In irradiation with a dose of 814 r there was seen a complete inhibition of antibody formation. Thus, although doses of 592 and 714 r are lethal for monkeys, they do not cause a complete inhibition of the immunological reactivity, which takes place only with a dose of 814 r. (auth)

1405 STUDIES OF RADIATION-INDUCED CHANGES IN CELLULAR PROLIFERATION, USING A DOUBLE LABELLING AUTORADIOGRAPHIC TECHNIQUE. D. R. Davies and D. E. Wimber (Brookhaven National Lab., Upton, N. Y.). Nature, 200: 229-32(Oct. 19, 1963). (BNL-7321)

An analysis was made (over an extended period of time) of the changes in the kinetics of an asynchronous cell population following a low dose of x rays. A double-labeling technique and staminal hairs produced within the flowers of a diploid clone of a variety of Tradescantia occidentalis were used to allow a more critical evaluation of the changes. The changes are described. (P.C.H.)

1406 RELATIVE BIOLOGICAL EFFICIENCY OF NEGATIVE μ-MESONS AND COBALT-60 γ-RAYS. D. R. Davies, A. H. Sparrow, R. G. Woodley, and A. Maschke (Brookhaven National Lab., Upton, N. Y.). Nature, 200: 277-8(Oct. 19, 1963). (BNL-7324)

The relative biological effectiveness of mesons (μ^-) and Co^{60} gamma rays in inducting somatic mutation in staminal hair cells of a diploid clone (02) derived from a variety of Tradescantia occidentalis was investigated. Eight fluorescences were exposed in air in the muon beam for each of the periods of time—2, 4, 6, 8, and 10 hr. As a standard for the muon treatments, influorescences were exposed in air at a dose rate of 7.5 rads/hr to four doses of Co^{60} gamma rays: 30, 48.7, 71.2, and 120 rads. Mutations were scored in the staminal hairs of flowers emerging on four successive days and the data relating yield per flower, to dose in rads, fitted to linear, $y = k + \alpha D$, and quadratic, $y = k + \alpha D + \beta D^2$, regressions. In all instances linear

regressions better fitted the data. The RBE of muons : γ is given by the ratio of the α coefficients, and has a mean value for all days of 0.79. (P.C.H.)

1407 RESISTANCE OF PHYTOHAEMAGGLUTININ-TREATED LYMPHOCYTES TO X-RAYS AND NITROGEN MUSTARD. Robert Schrek and Stefan Stefani (Veterans Administration Hospital, Hines, Ill.). Nature, 200: 482-3 (Nov. 2, 1963).

Suspensions of leukocytes were prepared from normal human blood. PHA-P (2 μl/ml) was added and the suspensions, in small test tubes, were irradiated with 75–2400 r and incubated at 37°C. After irradiation with 1200 r, 29% of the lymphocytes and transformed lymphocytes in the PHA-treated suspensions survived 6 days of incubation. In contrast, after irradiation with 150 r only 5.4% of the lymphocytes survived in control suspensions without PHA. The addition of nitrogen mustard 5 μg/ml allowed the survival of about one-half of the lymphocytes and lymphoblastoid cells. In contrast, the concentration of HN2 killed all the lymphocytes in control suspensions without PHA. (P.C.H.)

1408 PHOTO-REACTIVATION AFTER DIVISION II. John Calkins (Univ. of Texas, Houston). Nature, 200: 484-5(Nov. 2, 1963).

Since it was found that the lethal effect of ultraviolet light could be photo-reactivated in Tetrahymena pyriformis even after the irradiated individuals had divided once or twice, investigations were made to determine whether the observed response was a general characteristic or a special trait of the particular species and strain used. Late death was induced in Paramecium aurelia and ultraviolet doses were given at a rate of 10 ergs/mm^2/sec. Analysis for photo-reactivation after division was found to be analogous to that used for Tetrahymena pyriformis. (P.C.H.)

1409 A HIGH RELATIVE BIOLOGICAL EFFICIENCY OF 650-kev NEUTRONS AND 250-kvp X-RAYS IN SOMATIC MUTATION INDUCTION. D. R. Davies and J. L. Bateman (Brookhaven National Lab., Upton, N. Y.). Nature, 200: 485-6(Nov. 2, 1963).

The relative biological efficiency of 650-kev neutrons and 250-kvp x rays for the induction of somatic mutations in the staminal hair cells of a variety of Tradescantia occidentalis is described. Six inflorescences were irradiated at various neutron and x-ray doses, and somatic mutations were scored in the staminal hairs of the flowers emerging for six successive days. Linear $Y = k + \alpha D$ and quadratic $Y = k + \alpha D + \beta D^2$ regressions relating yield of mutations per flower to dose in rads were fitted to the neutron and x-ray data on each of the days. Linear equations more closely fitted the neutron data, and quadratic equations the x-ray data. The mean maximum relative biological efficiency value was 39.9. The relative biological efficiency values obtained with the experimental system used were higher than most of those observed for a variety of mammalian parameters. The explanation probably lies in the fact that, in the dose and dose-rate ranges used, the one-hit (α) component was of primary importance. (P.C.H.)

1410 EFFECT OF ULTRA-VIOLET IRRADIATION OF RIBONUCLEIC ACID ON ITS CHROMATOGRAPHIC BEHAVIOUR. H. Kubinski (Universitats Krankenhaus, Hamburg-Eppendorf, Ger.). Nature, 200: 595-6(Nov. 9, 1963).

Experiments were made to illustrate the effects of ultraviolet radiation on RNA isolated from uninfected mammalian cells as well as those from those infected with polio virus. The chromatographic recovery of irradiated RNA, as judged by ultraviolet adsorbance and radioactivity (no plaque formers were found after irradiation), was considerably lower than that of unirradiated RNA. (P.C.H.)

1411 DEATH OF FASCIOLA HEPATICA L. WEAKENED BY X-IRRADIATION. Ben Dawes (King's Coll., London). Nature, 200: 602; 603(Nov. 9, 1963).

Studies were made on mice infected with Fasciola hepatica L. and then x irradiated. It was found that the local tissue reaction of the host in normal infections is not directed against the parasite in order to exterminate it. Evidence was found to support the opinion that the local tissue reaction is directed toward the repair of damage caused by flukes burrowing in the liver and may be without effect on the parasites, unless these are weakened in some way and thereby brought into the sphere of influence of the inflammatory reaction. (P.C.H.)

1412 INHIBITORY EFFECT OF L-METHIONINE-METHYL-^{14}C ON OVIPOSITION BY FEMALES ON THE COTTON LEAF WORM, PRODENIA LITURA (F.), INDUCED BY RADIOACTIVE MALES. A. A. Abdel-Malek (Univ. of Cairo). Nature, 200: 604-5(Nov. 9, 1963).

Carbon-14 in distilled water, at dosages ranging from 0.05 to 5 μC per insect, was injected into the hemolymph of newly emerged moths of both sexes of Prodenia. After being injected, the radioactive moths of both sexes were associated with normal (non-radioactive) moths of the same stock and age, in different combinations: radioactive males with radioactive females; radioactive males with normal females; radioactive females with normal males; and normal females with normal males. The results showed that in every case a radioactive male moth was associated with either a radioactive or a normal female moth no eggs were laid by such females. Oviposition occurred only when the radioactive male moths either died or were taken away from their association with the female moths. In such cases the female moths began to lay egg batches two days later, but the eggs never hatched. (P.C.H.)

1413 THE EFFECT OF X-RADIATION ON THE EXCRETION OF RADIOACTIVE PHOSPHORUS BY THE URINE IN RATS. J. Koloušek and Z. Dienstbier (Charles Univ., Prague). Neoplasma, 10: 387-96(1963).

The effect of x radiation on the excretion of radioactive phosphorus (P^{32}) in the urine of rats was followed. Radioactive phosphorus was applied intraperitoneally within half an hour after irradiation, and its excretion was followed at intervals of 6, 12, 24, 48, and 72 hours after irradiation with doses of 10, 25, 50, 100, and 600 r. In addition, the effect of starvation, scalding, and administration of 2,4-dinitrophenol on the excretion of P^{32} in the urine of rats, was under investigation. It was found that: doses of 10 and 25 r lower the level of radioactive P^{32} in the urine of rats, as compared with a control group; from the dose of 50 r there occurs a significant rise in the excretion of radioactive phosphorus in the urine of rats; at the dose of 100 r this rise is still more accentuated; the amount of excreted radioactive phosphorus is a function of radiation dose, the dose of 50 r being the dose from which the mentioned effect is observed; after doses of 100 and 600 r there is a one-order difference between the amount of radioactive phosphorus excreted by irradiated animals and that, observe in control animals; the factor of starvation increases the excretion of labeled phosphorus by the urine of experimental as well as control animals as compared with fed rats, but there remains still a significant difference between the values obtained in irradiated animals and those observed

in control animals; severe scalding produces a contrary effect, i.e., it lowers the excretion of radioactive phosphorus in the urine in comparison with control animals; following administration of 2,4-dinitrophenol, excretion of P^{32} is increased in the same way as after irradiation. The increased excretion of radioactive phosphorus by the urine of rats after irradiation with x rays, as well as after the administration of 2,4-dinitrophenol is explained as disturbance of oxidative phosphorylation. (auth)

1414 LETHAL MUTATIONS AND CELL DEATH. Tikvah Alper (Hammersmith Hospital, London). Phys. Med. Biol., 8: 365-85(Nov. 1963).

From observations on the interaction of modifying treatments, it has been inferred that death of bacteria may result from at least two different types of event initiated by radiation, the involvement of oxygen in these events being intrinsically different. It was concluded that one type of damage, referred to as type N, has a rather low associated oxygen enhancement ratio; and comparisons of the effects of various modifying treatments on mutation induction and on cell death have suggested that radiation death resulting from type N damage is akin to the induction of lethal mutations; but death may also result from type O damage which is associated with a considerably higher oxygen enhancement ratio. The magnitude of the contribution by lethal mutations, i.e. by type N damage, to the overall bactericidal effect of radiation depends on the biochemical characteristics of the strain under test as well as on conditions during irradiation and culture conditions afterwards. While much less evidence is available on the modification of the cytocidal effects of radiation on higher cells, there is sufficient to suggest that the causal relationship of cell death to gross chromosomal damage may be only a rough approximation, the induction of chromosome damage by ionizing radiation may be due to more than than one type of initiating event, with more than one associated oxygen enhancement ratio. (auth)

1415 THYROID UPTAKE MEASUREMENTS WITH ^{132}I FOLLOWING ^{131}I THERAPY. T. J. Buchanan, M. Tulloch, and S. A. Aboul-Khair (Aberdeen Univ., Scotland). Phys. Med. Biol., 8: 399-406(Nov. 1963).

A method is described for measuring thyroid uptake with I^{132} in patients who have received a therapeutic dose of I^{131}. The activity of I^{132} required is 100 μC for therapeutic doses up to 12 mC. The uptake can be measured as early as one day after administration of the therapeutic dose. The change of uptake with time can be measured over many weeks, each uptake measurement requiring 100 μC I^{132}. The equipment consists of a standard directional scintillation counter modified by additional lead shielding. A simultaneous counting method is employed using two different discriminator bias voltages to provide discrimination of I^{132} against I^{131}. (auth)

1416 SYNERGISTIC ACTION OF NITROGEN MUSTARD AND RADIATION IN MICROORGANISMS. R. H. Haynes and W. R. Inch (Univ. of Chicago). Proc. Natl. Acad. Sci. U. S., 50: 839-46(Nov. 1963).

A technique is described for obtaining reproducible dose-effect curves (analogous to radiobiological survival curves) for the inactivation of microorganisms by the bifunctional alkylating agent, nitrogen mustard. The nitrogen mustard dose-effect curves for haploid and diploid yeast are similar in shape to the corresponding x-ray survival curves for these organisms, i.e., exponential for haploid and sigmoid for diploid. The LD90 dose ratio between the two ploidies is 4 for HN2 and 5 for x rays. E. coli B/r is more resistant to inactivation by HN2 than is E. coli B. Nitrogen mustard acts synergistically with both x rays and ultraviolet light in the inactivation of E. coli B/r, and diploid yeast, but only with ultraviolet light in haploid yeast. It is suggested that the formation by HN2 of sublethal structural defects in DNA serves to enhance the killing effect of both ultraviolet and ionizing radiations, and that synergistic effects arise through the mutual inhibition of reactivation processes that would otherwise serve to repair or by-pass some fraction of the molecular damage. (auth)

1417 THE EFFECT OF MITOTIC CYCLE DURATION OF CHROMOSOME BREAKAGE IN MERISTEMATIC CELLS OF PISUM SATIVUM. J. Van't Hof and A. H. Sparrow (Brookhaven National Lab., Upton, N. Y.). Proc. Natl. Acad. Sci. U. S., 50: 855-60(Nov. 1963).

Experiments were performed with seedlings of Pisum sativum to test the hypothesis that radiosensitivity with respect to chromosome damage increases during chronic irradiation with increased mitotic cycle time. Minimum cycle times were determined for root meristem cells. Temperatures of 30, 25, 15, and 10°C were used to obtain different minimum cycle times. The results of chronic exposures indicated that the minimum cycle time was not altered in Pisum sativum until the total exposure per cycle exceeded about 440–450 r; the percentage of cells showing damaged chromosomes at a stated daily exposure rate increased with decreasing temperatures if mitotic cycle time was not considered; but when the cycle time is taken into account, the production of damaged cells is a linear function of the amount of total exposure per mitotic cycle up to the critical value 440–450 r/cycle. (auth)

1418 SUCCESSIVE CHANGES IN THE CORNEA OF YOUNG AXOLOTL (SIREDON MEXICANUM) AFTER X-IRRADIATION. V. V. Brunst (Roswell Park Memorial Inst., Buffalo). Radiation Res., 20: 325-40(Nov. 1963).

The heads of 287 small axolotls were irradiated locally with 9000, 6000, 3000, 1000, 500, or 250 r. Fifty animals served as untreated controls. A histologic study of the specimens fixed at short intervals of irradiated and control corneas was made. After irradiation with 9000 r, the first change was noted 8 days later, and it progressed gradually until 18 days when the last surviving animal was fixed. The outer surface of the cornea became uneven, the cells enlarged, and melanophores appeared in the epithelium. The isolated projections of separate cells could be noted. The cornea gradually became completely disorganized and completely destroyed. After irradiation with 6000 r, the first changes in the corneal epithelium could be noted 18 days after treatment. Thirty days after irradiation, many very great compact melanophores and small pigment granules were observed in the corneal epithelium. The number of cells were greatly reduced, and some of them were of giant size. Isolated projections from the epithelium were also observed. After irradiation with 3000 r, definite morphological changes of the epithelium were observed 22 days after irradiation. Thirty-five days after irradiation, disorganization of the corneal epithelium was observed. Only isolated giant epithelial cells were seen. After complete destruction of the corneal epithelium, it was replaced by a typical skin epithelium with many Leydig cells. After irradiation with 1000 r and 500 r, the typical primary changes were observed at 21 days. In some cases, the corneal epithelium completely recovered, and in others it completely disappeared and was replaced with skin epithelium. After irradiation with 250 r, destruction of the corneal epithelium was not observed, but in some cases a very thick corneal

epithelium was seen which was three to four times as thick as the epithelium of control animals. The development of melanophores in the cornea is a result of irradiation. Normally, the cornea has no melanophores. In control animals they were never observed in the cornea. The peculiar resistance to irradiation of eye pigment cells in the chloroid is emphasized and contrasts greatly with sensitivity of melanophores in other regions of the body of amphibians and mammals, e.g., graying of hairs after irradiation. Resistance and the progressive development of melanophores in new regions such as epithelium or cornea were observed. (auth)

1419 EFFECTS OF WHOLE-BODY X-IRRADIATION ON ERYTHROCYTE METABOLISM. Gordon C. Mills, Dorothy O. Burger, Martin Schneider, and William C. Levin (Univ. of Texas, Galveston). Radiation Res., 20: 341-9(Nov. 1963).

Effects of therapeutically applied whole-body x irradiation were studied on nucleotides and other components of human erythrocytes. Diphosphopyridine nucleotide and triphosphopyridine nucleotide were significantly elevated in the 1- to 4-day period after irradiation. Uric acid was significantly increased 24 hr postirradiation. The possible significance of these results in relation to known effects of radiation is discussed. Erythrocyte glycolysis was studied in human subjects, dogs, and rabbits after whole-body x irradiation. Statistical evaluation of these results indicates that irradiation does not affect erythrocyte glycolysis in any consistent manner. (auth)

1420 RADIORESISTANT MUTANTS OF ESCHERICHIA COLI B (ORNL). Joseph Greenberg and Pearl Woody-Karrer (Palo Alto Medical Research Foundation, Calif.). Radiation Res., 20: 350-63(Nov. 1963).

Radio-resistant mutants of E. coli B (ORNL) were isolated from among survivors of treatment with uv radiation and with 1-methyl-3-nitro-1-nitrosoguanidine. The mutants surviving uv irradiation were equally resistant to uv and x radiation but could be differentiated into four classes on the basis of their cross-resistance to radiomimetic chemicals. Two of these classes also represented all the radioresistant mutants isolated after 1-methyl-3-nitro-1-nitrosoguanidine treatment. The radioresistant mutants of B (ORNL) differ from those isolated earlier by other investigators. They all also differ from the radioresistant mutants isolated from E. coli S, a variant of strain B. An explanation for the observed differences among radioresistant strains of B isolated at different times is presented. (auth)

1421 EFFECTS OF SUBLETHAL IRRADIATION ON PARABIOSIS INTOXICATION IN HOLTZMAN–CFN PARABIONTS. Robert T. Binhammer and Burton G. Must (Univ. of Cincinnati). Radiation Res., 20: 364-71(Nov. 1963).

Parabiosis of Holtzman and Carworth Farms Nelson rats resulted in parabiosis intoxication in approximately 45% of pairs and death in approximately half of those with disease. In the majority of cases the anemia was found in the CFN partner. In the majority of surviving animals, dehiscence of the union was evident at 30 days after pairing, and lack of permanent union was indicated by lack of cross-circulation. Sublethal irradiation of either Holtzman or CFN partners accentuated and increased the incidence of anemia in the Holtzman rat at 3 days after pairing and irradiation of the CFN partner resulted in an increased incidence of late disease and a high mortality rate. The incidence of intoxication was decreased somewhat by irradiation of Holtzman partners. Irradiation of both Holtzman and CFN partners resulted in an incidence of intoxication which was not different from that in H–CFN controls. In all but one of surviving pairs, in which one or both partners received irradiation, permanency of union was shown by the existence of cross-circulation at 30 and 60 days after joining. (auth)

1422 AGE AND HEMATOLOGICAL RECOVERY FROM ACUTE WHOLE-BODY X-IRRADIATION. Roberts Rugh and Graciela Pardo (Columbia Univ., New York). Radiation Res., 20: 399-422(Nov. 1963).

Prior to x irradiation, some 84 mice, similar to 45 used for the experiment, were given full blood analyses. The composite of 129 control mice gave the base line of normal blood evaluations for comparison with the blood averages of x-irradiated mice. The normal variations between the young virgins, mature, and the old females, were not age-specific and fell within the normal ranges. Multinucleate lymphocytes were found in 84.5% of all unirradiated mice of the three ages studied. Exposure of mice of different ages to 300 r of x rays caused permanent average depression of the platelets of all mice and of the hemoglobin and RBC of the old mice, and slight average depression of the RBC, but not of the hemoglobin, of the mature mice. Complete recovery from x irradiation insult was seen in the RBC and hemoglobin of the young, and in the hemoglobin only of the mature mice. By all tests the old mice showed the poorest recovery, and in RBC, platelets, and hemoglobin they showed permanent and severe average depression. The cytoplasmic inclusions, which have never been seen in blood of unirradiated control mice, appear to be nuclear fragments, and their appearance and occurrence may be diagnostic of x irradiation insult. (73 references) (auth)

1423 A METHOD OF CHARACTERIZING PROTEIN CHANGES IN SERUM AFTER X-IRRADIATION. D. G. Baker (Univ. of Toronto), A. L. Carsten, and C. Safford. Radiation Res., 20: 431-42(Nov. 1963). (BNL-7118)

A method of analyzing starch gel electrophoretic patterns was developed. Separation of the plasma proteins into well-defined groups was obtained by electromigration through a starch gel medium. Staining of these gels with Amido Black produces a characteristic pattern of protein fractions. By photographing these gels and evaluating the negatives with a recording densitometer, it was possible to gain a previously unattainable degree of definition. The resulting patterns were then analyzed by means of an expanding scale technique. This was applied to the plasma proteins from groups of young and old rats, and to rats at various times after exposure to whole-body x irradiation. The qualitative changes in the protein spectrum which occurred with age and irradiation included a general decrease in electrophoretic mobility and an increase in the variability of the rate of electrophoretic migration of most fractions. A possible mechanism for these changes is discussed. (auth)

1424 INDUCTION OF ABERRATIONS IN MEIOTIC CHROMOSOMES OF WHEAT BY MEANS OF THYMIDINE-H^3. H. A. McQuade (Univ. of Missouri, Columbia). Radiation Res., 20: 451-65(Nov. 1963).

Embryos removed from wheat seeds which had taken up water for 4 hr were incubated in thymidine-d for 4 hr, and then grown on isotope-free medium for 1 hr. No activity was found in these embryos. Since 16 hr is required for visible germination at 25°C, it may be assumed that cell division with consequent incorporation of radiothymidine in DNA must begin sometime during the second half of the pregermination period. Localization of thymidine-d during the periods 1 to 5, 4 to 9, and 8 to 13 hr after germination

appeared to be in about the same amounts and indicated that cell division was proceeding at an even rate over these periods. The primary root, both lateral roots, and coleoptile were the most active organs. The first foliage leaf was the next most active component. The high incidence of stunting and retardation in wheat seedlings after germination of seeds in thymidine-d was due largely to radiation injury of the early root system. Injury to the seedling root system was also the commonest effect after embryo incubation in thymidine-d; effects in the epicotyl were slightly fewer. This would be expected in view of thymidine localization. During the period 24 to 48 hr after germination, the first lateral roots surpassed the primary root in uptake of thymidine-d as they enlongated and passed the primary in length. The coleoptile, which doubled in length during this period, had a thymidine-d content slightly less than in the earlier periods. Cell elongation was, therefore, the chief contributor to coleoptile growth during this period. Increase in length of the first foilage leaf during this period was also through cell elongation. Thymidine moved from the endosperm to the developing embryo. The low yields of chromosome aberrations in pollen mother cells of adult plants arising from embryos incubated in thymidine-d or from seedlings with epicotyls cut back and then immersed in radiothymidine are accounted for on the basis of the following considerations. There are about 200 cells in the growing point at 24, 48, or 72 hr postgermination. The uptake of thymidine-d in the growing point was limited because only a few cells were in division, and the number of cells in DNA synthesis at any one time would therefore be small. Thus, radioautographs of serial sections showed strong label in the growing point in only two of fifteen embryos given a 24-hr exposure to thymidine-d, even when coleoptiles were cut back and the embryo was submerged upside down to ensure contact with isotope. The growing point was surrounded by organs which contained many dividing cells. Pronounced label was found in coleoptile, first foliage leaf, second foliage leaf, meristematic area proximal to growing point, third foilage leaf, and bases of roots in radioautographs of serial sections. Although some seedlings died of radiation damage after embryo treatment with thymidine-d, many eventually recovered the normal phenotype. This suggests that enough undamaged or only partially damaged cells survived within the injured organs to proliferate and eventually produce normal structures. The incidence of aberrations in meiotic chromosomes increased when exposure time of the growing point to isotope was increased and isotope was replenished to ensure its availability to the relatively few cells of the growing point undergoing DNA synthesis at any one time. (auth)

1425 AVOIDANCE CONDITIONING OF NaCl WITH X-IRRADIATION OF THE RAT. Nathan W. Perry, Jr. (Florida State Univ., Tallahassee). Radiation Res., 20: 471-6(Nov. 1963).

Rats developed an avoidance to a previously preferred saline solution (0.8%) when the solution was drunk during nonlethal ionizing irradiation, and response to a control saline solution (0.002%) was not affected. Rats given the control solution with irradiation, given irradiation alone, given the preferred solution alone, or given neither irradiation nor solution all maintained the initial preference. Effectiveness of the irradiation was dependent on the initial preference strength. Rats with lowest initial preference were significantly more likely to develop the avoidance. The response measure was the number of tongue licks and was recorded electronically. The results support a conclusion that ionizing radiation can serve as an unconditioned stimulus in a classical conditioning framework although used in temporal intervals of hours rather than seconds. (auth)

1426 SURVIVAL STUDIES OF WHOLE-BODY X-IRRADIATED GERMFREE (AXENIC) MICE. B. Raphael Wilson (Univ. of Notre Dame, Ind.). Radiation Res., 20: 477-83(Nov. 1963).

The response of germfree (axenic) Swiss-Webster mice to whole-body x irradiation at 500 to 3000 r was compared to that of conventional Swiss-Webster mice. The $LD_{50(30)}$ dose for axenic mice was 705 r, and that for conventional mice was 660 r. The slopes of the dose-response curves were the same. However, the survival times at a given dose were markedly different. On a log-log scale the relation between dose and survival time is linear, the 650- to 3000-r range producing mean survival times from 15 to 7 days. The survival time of conventional mice is about 4 days less than for axenic mice in the 500 to 1000-r range and then drops sharply to a plateau of between 3 and 4 days. (auth)

1427 CANCER IN THE RAT AFTER SINGLE EXPOSURES TO IRRADIATION OR HYDROCARBONS. AGE AND STRAIN FACTORS. HORMONE DEPENDENCE OF THE MAMMARY CANCERS. Charles Huggins and Ryo Fukunishi (Univ. of Chicago). Radiation Res., 20: 493-504 (Nov. 1963).

Single whole-body x irradiation (400 r) exerted selective cell damage in female rats. Hemopoietic tissues were damaged, and cancer was induced selectively in mammary gland and fibroblast. Among the undamaged tissues were pituitary, ovary, and vagina, which remained functionally intact, since regular estrus cycles persisted. The racial strain of origin of the rats had a profound influence on the development of mammary cancer after whole-body irradiation. Females of the Sprague-Dawley strain developed both sarcoma and mammary carcinoma. In females of the Long-Evans strain, sarcomas were induced but mammary carcinoma was not observed. The tumors characteristic of each strain arose when irradiation was provided to neonatal (age 3 days) or adult rats. Mammary carcinoma was detected soon after irradiation, and sarcoma at a later time. In Sprague-Dawley females given a single whole-body x-irradiation (400 r) at age 52 days, mammary carcinomas had the following characteristics: incidence in 29.7% of rats; 92% of the cancers detected within 79 days; multiple carcinomas found in 13% of cancerous rats. In sisters given two x irradiations (400 r) at 52 and 92 days, mammary carcinomas had the following characteristics: incidence in 60% of rats; tumors detected in a continuous series from 25 to 220 days; multiple intravenous injection of 5 mg of 7,12-dimethylbenz (a) anthracene, was more efficient than x irradiation (400 r) in induction of mammary cancer; incidence, 100%; rats with multiple tumors, 68%. A newly recognized property of radioinduced mammary carcinoma of rat is hormone dependence of the cancers. Mammary carcinomas in Sprague-Dawley rats, induced by radiation or by polycyclic aromatic hydrocarbons, shared the following qualities: similar histological appearance; similar regressive properties after ovariectomy; and similar content of the five dehydrogenases, glucose-6-phosphate, 6-phosphogluconic, isocitric, lactic, and malic. (auth)

1428 NOTES ON DYNAMIC PROCESSES OF THERMOREGULATION IN WHITE MICE. Chu-ying Cheng, Yun-jiu Wang, and Shu-zhen Shi (Inst. of Biophysics, Academia Sinica, Peking). Sci Sinica (Peking), 12: 1593-5 (Oct. 1963).

Employing a servo-mechanism, changes in dynamic processes of thermoregulation were demonstrated in white mice exposed to lethal doses of x rays. Contrary to previous observations of affected thermoregulation on the day of irradiation, significant changes in thermoregulation dynamic processes did not occur until the third day post irradiation. All changes appeared after the animals were moribund. Therefore, death could not be attributed directly to decrease in thermoregulatory performance. It is suggested that post-irradiation regulation may be affected by exhaustion of the animal. Although dynamic processes become unfavorable after irradiation, the steady state remains unchanged. (H.M.G.)

1429 RESTITUTION OF LIVER MITOCHONDRIA IN WHOLE-BODY IRRADIATED MICE. Fu-Yu Yang, Zhi-huan Lin, Jin-zhao Li, and Sheng-guang Li (Inst. of Biophysics, Academia Sinica, Peking). Sci. Sinica (Peking), 12: 1595-7(Oct. 1963).

Characteristics of swelling, the degree of coupling of oxidative phosphorylation-respiratory control, and P/O ratios of mitochondria in early post-irradiation stages were examined. White male mice were given a dose of 700 r x rays and killed 30 minutes, 1 hour, and 4 hours after exposure. Spontaneous swelling of liver mitochondria 30 minutes and 1 hour after exposure is markedly increased: an essentially normal condition if found at 4 hours. Contrasting of these results with those from thyroxine or Ca^{2+}-induced swelling, it is suggested that a slight alteration in structural integrity is involved in the early post-irradiation stage. The respiratory control index of mitochondria falls off 30 min after exposure and reaches a minimum 1 hour post-irradiation. A slight depression of P/O ratios appears only 1 hour after irradiation. Nearly complete or complete recovery of both respiratory control index and P/O ratio is achieved by 4 hours. Parallel with the biochemical lesion are the decrease and subsequent increase in the protein content of the mitochondrial suspension per gram of fresh liver tissue. From the results of this study and the electron-microscopic observations of Mochituk, it appears that the mitochondria of mouse liver are transiently damaged both structurally and functionally in vivo, but are soon restituted to reach pre-irradiation levels. (H.M.G.)

1430 COSMIC RADIATION AND CANCER. I. INFLUENCE OF COSMIC RADIATION AT SEA-LEVEL ON INDUCED CANCER. S. G. Ong (Inst. of Epidemiology and Microbiology, Academy of Medical Sciences, Peking). Sci. Sinica (Peking), 12: 1760-1(Nov. 1963).

To study the influence of cosmic radiation on cancer induction, 260 mice were injected subcutaneously with 0.5 mg 20-methylcholanthrene in sesame oil and exposed under varying thicknesses of lead shielding to cosmic radiation. Examination for tumors was performed twice a week for 138 days. Results of the analysis of variance showed that the mean latent period for 2 cm of Pb is significantly lower than for no shielding and also for 10 cm of Pb. The mean for 5 cm of Pb was considerably lower than that for 10 cm of Pb. There was no significant difference between the means for 1, 2, and 5 cm of Pb, and no great difference between the mean for no Pb and 10 cm of Pb. An increase in photon-electron showers in 2 cm of Pb corresponded to the lowest latent period observed. Results suggest that there is a significant reduction of the latent period for the induction of tumors due to the photon-electron showers as compared with 0 and 10 cm of Pb. Development of tumors was found not to be sex-dependent. (H.M.G.)

1431 STRAHLENWIRKUNG UND MILIEU. INTERNATIONALES RADIOBIOLOGISCHES SYMPOSIUM IN MONTREUX VOM 28. MAI BIS 3. JUNE 1961. (Radiation Effects and Milieu. International Radiobiological Symposium, Montreux, May 28 to June 3, 1961). Hedi Fritz-Niggli. Strahlentherapie, Sonderbaende, 51: 1-333(1962). Munich, Verlag von Urban and Schwarzenberg, 1962. 333p.

Separate abstracts were prepared on 22 papers presented at this symposium. Seven papers covering various aspects of the effects of environment on radiosensitivity were previously abstracted and appeared in NSA. (C.H.)

For abstracts of individual papers see: 1432, 1433, 1434, 1435, 1436, 1437, 1438, 1439, 1440, 1441, 1442, 1443, 1444, 1445, 1458, 1459, 1460, 1478, 1479, 1776, 1777, and 1778.

1432 ELECTRON SPIN RESONANCES IN BIOLOGICAL SYSTEMS AND INFLUENCING BY RADIATION AND SURROUNDING GASES. Karl G. Zimmer (Kernforschungszentrum, Karlsruhe, Ger.). Strahlentherapie, Sonderbaende, 51: 46-57(1962). (In German)

The many possibilities for using electron-spin-resonance measurements in radiobiology are reviewed. Possible sources of error for pertinent results are described. Comparisons may be made for spectra that are obtained from the same material, but are taken under different conditions. The appearance of spin-resonance absorption in unirradiated biological objects is discussed, especially the general significance of the observed anomalous spectra of bacteriophages and viruses. (tr-auth)

1433 EFFECTS OF MILIEU ON IMMEDIATE RADIATION RESPONSE OF BIOLOGICAL MOLECULES WITHIN THE CELL. Franklin Hutchinson (Yale Univ., New Haven). Strahlentherapie, Sonderbaende, 51: 58-70(1962). (In English)

The effects of environment on the radiosensitivity of molecules within irradiated cells are discussed. Emphasis is placed on the effects of O_2 and H_2O on immediate effects produced directly by radiation. Results are reported from studies on the effects of environment on the radiosensitivity of enzymes, energy transfer from water to a macromolecule, and reaction mechanisms of the direct effect of radiation. The effect of the formation of water radicals in wet cells on radiosensitivity is discussed. (C.H.)

1434 TIME AND MILIEU DEPENDENCE OF ELECTRON RESONANCE SPECTRA OF X-IRRADIATED FIBROUS PROTEINS AND AMINO ACIDS. Albrecht Redhardt (Max-Planck-Institut für Biophysik, Frankfurt am Main). Strahlentherapie, Sonderbaende, 51: 71-82(1962). (In German)

The complex processes in x-ray-irradiated keratines occur in the region where the electron-spin-resonance method is accessible and a simple reaction scheme cannot be prepared. Three reactions were detected: a fleeting line at the place of the free electron; a broad, also fleeting line, which appears especially on the cystine-poor keratine (quill) after drying and is strongly influenced by bound water; and a slow migration of the radical state of cystine, which is directly observable in dried, cystine-poor keratine (quill). In the dried, x-ray-irradiated keratine, the portion of cystine-like radicals is relatively low; a value of between 50 and 70% was observed. In quantitative studies there was no evidence for energy transfer in proteins from non-cystine residues to cystine. The cystine-like spectra in keratines were more stable than those from other amino acid residues. (M.C.G.)

1435 EFFECTS OF IRRADIATION IN TOTO ON THE ENZYMATIC ACTIVITY OF LEUCOCYTES. Jean-Albert Antonioli and Alfredo Vannotti (Clinique Médicale Universitaire, Lausanne, Switzerland). Strahlentherapie, Sonderbaende, 51: 83-95(1962). (In French)

Studies were carried out on x-irradiated male guinea pigs. The pigs were divided into three groups: an unirradiated control; an irradiated group sacrificed at 2 hr postirradiation; and an irradiated group sacrificed at 26 hr postirradiation. The dose for the irradiated groups was 250 r, which is about the LD_{50}. The enzymatic activities of the acidic and alkaline phosphatases; esterase; lipase; dehydrogenases of glutamic acid, malic acid, isocitric acid; aspartic-glutamic transaminase; and alanine-glutamic transaminase were measured in the leukocyte component of the blood of each of these experimental groups. It was found that: variations in the blood composition are accompanied by modifications of the biochemical behavior of the leukocytes; and the enzymes in the granulocytes and lymphocytes vary in radiosensitivity. (T.F.H.)

1436 THE SIGNIFICANCE OF THE OXYGEN EFFECT ON CHROMOSOME BREAKAGE BY IONIZING RADIATION. Gerard J. Neary (Medical Research Council Radiobiological Research Unit, Harwell, Berks, Eng.). Strahlentherapie, Sonderbaende, 51: 96-102(1962). (In English)

The radiation-induced breakage of chromosomes is considered in relation to the presence or absence of oxygen during irradiation and the factor of LET. It is shown how such data provide, in principle at least, critical tests of some of the proposed mechanisms by which chromosome aberrations are produced and thus have a bearing on the problem of chromosome duplication. (auth)

1437 ARTEMIA SALINA LEACH, A NEW MATERIAL FOR RADIOBIOLOGICAL RESEARCH. Pietro Metalli and Elda Ballardin (Università, Milan). Strahlentherapie, Sonderbaende, 51: 126-8(1962). (In English)

The suitability of Artemia salina as a biological material for studies on radiosensitivity in different genotypes and environmental conditions is discussed. It is pointed out that this salt water Crustacean is naturally found in different strains or biotypes and can be easily cultured in the laboratory under a wide variety of conditions, such as temperature, pH and salinity of the medium, and light intensity. Artemia salina reproduces by both bisexual and parthenogenic methods, and the chromosome number may be diploid, tetraploid, octoploid, or heteroploid. Ploidy and reproductive mechanisms can combine in different ways. The relation between radiosensitivity and chromosome number can be studied at both the somatic whole-body level and at the cellular level in Artemia salina. Results are reported from studies on the effects of x radiation on the hatchability of dry eggs from natural amphigonic diploid and tetraploid populations and differences in radiosensitivity of different larval stages of development of these strains. (C.H.)

1438 BACK-MUTATION DEPENDENCE ON CELL STATE AND THE AGENT OF FORWARD INDUCTION. Heidi Fritz-Niggli (Universitllt, Zurich). Strahlentherapie, Sonderbaende, 51: 129-39(1962). (In German)

Ionizing radiation caused back-mutation in yeast. The mutation rates of the individual mutants were not very different from one another. They depended on an approximately linear dose-effect relation. It was found that the radioinduction of back-mutation depends on the physiological state of the cell. Point mutation appeared to be subject to the same laws as chromosome mutation. The dividing cell was found to be essentially (up to four-fold) more radiation sensitive than the cells not in the process of dividing. During the irradiation of x-ray mutants in 100% N_2 with 3000 and 15000 r in the mitotically active stage, the back-mutations were depressed. Dinitrophenol-treatment before or during the irradiation exerted no influence on the radioinduced mutation process. (tr-auth)

1439 MUTATIONS AND THE CONCEPT OF VIABILITY. Ake Gustafsson (Royal Coll. of Forestry, Stockholm). Strahlentherapie, Sonderbaende, 51: 140-51(1962). (In English)

Pioneer work on the induction of plant mutations by ionizing radiations, ultraviolet radiation, and chemical mutagens is reviewed. The importance of spontaneous and induced mutations in plant breeding programs is discussed. Screening and selection techniques for the isolation of plant mutants are described. The induction of mutations in tobacco, barley, peas, peanuts, white mustard, oats, tree and bush fruits, and the induction of disease-resistant mutants in plants is reviewed. It is concluded that high-yield mutants of agricultural plants can be produced by the use of chemical mutagens alone or in combination with ionizing radiations. (C.H.)

1440 EFFECTS OF IONIZING RADIATIONS ON VARIABILITY IN CORN. Renzo E. Scossiroli (Università, Pavia, Italy). Strahlentherapie, Sonderbaende, 51: 156-9 (1962). (In English)

Results are reported from a study of the effects of doses of 1500 r and 3000 r x radiation to the tassel on genetic variability in a strain of corn obtained from doubling of the haploid chromosome set in monoploid plants. Two days after the radiation treatment the pollen was collected and used to self the proper mother plant. Selfing was repeated the following year on a sample of 5 plants within each group, and the following year on 3 plants of each subline. Analysis of variance was applied and the components of each variance were obtained. Data are tabulated and results are discussed. (C.H.)

1441 THE EFFECT OF DOSE FRACTIONATION ON MUTATION INDUCTION. D. Roy Davies (Atomic Energy Research Establishment, Harwell, Berks, Eng.). Strahlentherapie, Sonderbaende, 51: 160-70(1962). (In English)

Somatic mutation rates at the leaf marking locus in Trifolium repens were determined following exposure to acute and fractionated doses of gamma radiation. Certain dose fractionation treatments led to a reduction in the number of mutations recovered, to a value below the base line of additive effects of the two fractions. Doses as low as 12.5 rads induced protection, and a somewhat similar degree of protection was produced by a range of initial doses. The phenomenon developed within a short period of time after irradiation, and its development was related to temperature. Mutations took longer to develop and persisted for a greater length of time at lower temperatures. The protective effect was observed only if the initial fraction was given in the presence of air or oxygen. Attempts were made to interpret the radiation induced protection in terms of induced metabolic changes within the tissues. (auth)

1442 A REVIEW OF FACTORS AFFECTING THE INCIDENCE OF RADIATION-INDUCED LETHALS IN MAMMALS. A. G. Searle (Medical Research Council Radiobiological Research Unit, Harwell, Berks, Eng.). Strahlentherapie, Sonderbaende, 51: 215-23(1962). (In English)

Problems encountered in studies of the effect of environment on radioinduced mutations in mammals are discussed. Available data are reviewed on the influence of genetic factors on the rate of radioinduced lethals in mammals.

Results are reported from a study of the rate of dominant lethal induction in various mouse strains after the exposure of males to 600 r x radiation. The importance of knowledge of various genetic and environmental factors on the effects of various radiation doses in mammals is stressed. (C.H.)

1443 PATHOGENESIS AND REGENERATION OF RADIATION INDUCED BONE MARROW INJURY, AND THERAPEUTIC IMPLICATIONS. Theodor M. Fliedner, Eugene P. Cronkite, and Victor P. Bond (Brookhaven National Lab., Upton, N. Y.). Strahlentherapie, Sonderbaende, 51: 263-78(1962). (In English)

The hematological data of patients of 4 radiation accidents (Rongelap 1954, Oak Ridge 1958, Vinca 1958, Lockport 1960) are reviewed and compared. The blood cell curves appear to show three phases. These are an initial phase (about 8 to 10 days), a phase of transient or abortive regenerations, and a phase of final effective recovery. These phases in the blood are preceded and caused by particular events in the bone marrow. Evidence was brought forward that transient rises in leukocytes and reticulocytes associated with a delayed platelet disappearance curve are associated with a marrow capable of spontaneous recovery. In patients with inhomogenous total-body irradiation, the transient rise may lead directly of effective recovery. Immediate decline of all blood cell elements without evidence of further, even abortive attempts of marrow regeneration must be considered as evidence for a lethal bone marrow dose and extremely serious complications may be expected. The clinical implications of these analyses are outlined and the diagnostic possibilities described. (auth)

1444 ALLOGENIC GRAFTING (IN PARTICULAR OF BONE MARROW) AFTER TOTAL-BODY IRRADIATION OF MAN. Georges Mathé (Hôpital Saint-Louis, Paris). Strahlentherapie, Sonderbaende, 51: 279-94(1962). (In French)

The use of total-body irradiation of humans as a means of breaking down their resistance to allogenic grafts was studied. The studies comprise bone-marrow grafts to juvenile acute leukemia patients, and kidney transplants to adults. The doses administered are on the order of 500 rad. An additional study was made of marrow grafts to accidentally irradiated workers, for whom the dose is not known. It is concluded that the response of the human to grafting accompanied by irradiation may not be very different from that of other species, as regards the amount of irradiation required. No cases of permanent grafts were observed. (T.F.H.)

1445 DOSE-EFFECT RELATIONS IN CLINICS AND EXPERIMENTS. Heinz Oeser (Freie Universität, Berlin). Strahlentherapie, Sonderbaende, 51: 312-24(1962). (In German)

In experiments and by observations of men, who were irradiated for therapeutic purposes, the following dose-effect relations were studied: the behavior of cerebral currents in electroencephalograms during and after the action of ionizing radiation; the weight changes of eye lens in relation to absorbed radiation dose, age, and observation time; and dose-effect relation in the radiation treatment of malignant tumors. (M.C.G.)

1446 REPAIR AND DIFFERENTIAL SENSITIVITY TO MUTATION INDUCTION: SUMMARY AND SYNTHESIS. R. F. Kimball (Oak Ridge National Lab., Tenn.). p.427-41 of "Repair from Genetic Radiation." New York, Pergamon Press, 1963.

Mutagenic mechanisms are considered with special reference to periods of mutagenesis, nature of initial lesions, chromosomal aberrations, inactivation and mutation, radiation dose rate and dose fractionation effects, and stage sensitivity. (H.M.G.)

1447 NASA FACILITY FOR THE STUDY OF SPACE RADIATION EFFECTS. David R. Johnson (Langley Research Center, Hampton, Va.). 18p. (CONF-289-1)

From the Institute of Electrical and Electronics Engineers Region 3 Meeting, Richmond, Va., Apr. 1963.

Information on the energies and fluxes of trapped electrons and protons in space is summarized, and the Space Radiation Effects Laboratory being constructed to simulate most of the space particulate-energy spectrum is described. A 600-Mev proton synchrocyclotron of variable energy and electron accelerators of 1 to 10 Mev will be included. The accelerator characteristics and the arrangement of the experimental and support buildings, particularly the beam facilities, are discussed; and the planned activities of the laboratory are given. (D.C.W.)

Radiation Effects Therapy and Countermeasures

1448 (NAS-NRC-Pub-1134) THE TREATMENT OF RADIATION INJURY. (National Research Council. Committee on Pathologic Effects of Atomic Radiation). 1963. 23p.

The symptoms and treatment of acute radiation injuries in man are discussed. It is pointed out that the acute radiation syndrome following whole-body irradiation varies in both nature and severity, depending upon the dose, dose rate, dose distribution, and individual susceptibility. Signs and symptoms of central nervous system involvement appear immediately after high doses of penetrating radiation. Lower doses are followed by a latent period of apparent well-being, that lasts until pathological changes, initiated at the time of exposure, are sufficiently advanced to be manifest by clinical disturbances of the gastrointestinal tract, hemopoietic system, or both. Early symptomology is a useful guide to management and the treatment must be determined by the type and extent of injury. Fluid balance and daily weight should be measured and prophylactic doses of antibiotics given if indicated. Tranquilizers and sedation may be used to relieve the apprehension of the patient. Blood transfusions are of no value except in the case of severe anemia or rapid blood loss and blood platelets should be given only when there is a life-threatening hemorrhagic diathesis. Measures should be taken to reduce physical stresses, and judicious medical care given. External contaminants should be removed as promptly as possible. The administration of chelating agents in the case of the ingestion of large quantities of radioactive nuclides and of Lugol's solution to reduce I^{131} uptake by the thyroid are discussed. Data are appended on the treatment of persons exposed in the Marshall Islands accident in 1954, the Y-12 accident in 1958, and the Lockport accident in 1960. (C.H.)

1449 SUPPRESSION BY CYSTEAMINE OF RADIOSENSITIZATION IN 5-BROMODEOXYURIDINE SUBSTITUTED PHAGE T1. Gerhart Hotz (Kernforschungszentrum, Karlsruhe, Ger.). Biochem. Biophys. Res. Commun., 11: 393-8(1963). (KFK-161)

Recently it was shown that the formation of a free radical by ionizing radiation in thymine requires 1200 ev but in 5-bromouracil only 150 ev. On the strength that this

finding may be of importance for designing a model for the sensitizing action of halogen-substituted DNA-bases, an investigation was made of the effect of a sulfhydryl compound on preventing or repairing particularly those additional radiolesions observed in BUDR-labeled phage. In order to replace thymidine by 5-bromodeoxyuridine, T1 wildtype phage was grown according to the method of Stohl et al. Irradiation was accomplished via a Co^{60} gamma-source and a 6-watt Hanau low-pressure uv-lamp. Results indicate that: the sensitizing effect is observed in phage irradiated with uv as well as γ; BUDR sensitizes T1 by equal factors (about 2) independently of the conditions for ionizing radiation; cysteamine, if present during irradiation, removes completely the radiosensitization in wet BUDR-phage, but not in dry systems. It was concluded that radiosensitization due to incorporation of halogen-substituted base analogues into phage-DNA has the same origin for uv and ionizing radiation. (H.M.G.)

1450 EXPERIENCES WITH PROTECTIVE EFFECTS OF BONE MARROW CULTURES IN INJURIOUS EFFECTS OF IONIZING RADIATION. Sandor Nagy and Gyula Petraenyi (Debreceni Orvostudomanyi Egyetem, Debrecen, Hungary). Magy. Belorv. Arch., 14: 56-9(May 1961). (In Hungarian)

Various aspects of experimentation in bone marrow cultures and their protective qualities against irradiation are discussed. Bone marrow cells obtained from rats, mice, and guinea pigs were cultured in vitro and tested for protective ability. They were fixed to reconstituted collagen membranes and suspended in the following nutrient medium: a Hank's solution base to which were added 10 μg vitamin B_{12}, 40 μg adenosine triphosphate, 0.002 g vitamin C, 0.0004 nicotinic acid, 0.003 vitamin B_1, 0.006 methionine, 0.015 choline, 0.006 inositol, 0.014 valine, 0.005 cystine, 0.01 DL-leucine, 0.015 L-lysine, 0.005 L-histidine, 0.002 L-arginine, 0.002 L-tryptophan, 0.005 glutathione, 0.140 glutamic acid, 0.005 ribose, and 0.005 deoxyribose. The final composition of the medium consisted of 75% of the above modified Hank's solution, 25% human ascites fluid, 1 g lyophilized embryo extract per 100 ml, 50,000 units penicillin, and 20 μg streptomycin. The cultures were incubated at 37°C and examined daily, the solution being changed every 3 days. The changes in the bone marrow cells during culture are described, with particular reference to the fibroblast-like cells which developed. Three groups of rats were irradiated with 750 r; the control group received no transfusion, a 2nd group received 8 million cultured cells intravenously at 3 hr and another 6 million cells intraperitoneally 12-hr postirradiation. The 3rd group received fresh bone marrow cells at the same time intervals. As a protective measure the animals received streptomycin daily. All animals in the 1st two groups died after 22 days, whereas 80% of the 3rd group survived. The results suggest that bone marrow cells either do not multiply in cultures, or if they do multiply it is as fibroblast-like cells. Obviously, such cultures are incapable of producing new hematopoietic cells which will support the irradiated recipient through the acute phase of radiation disease. (BBB)

1451 CITRIN EFFECTS ON PERMEABILITY OF HISTO-HEMATIC BARRIER IN SPLEEN DURING A SINGLE ADMINISTRATION OF Po^{210}. V. V. Dunaev. Med. Radiol., 8: No. 9, 53-5(Sept. 1963). (In Russian)

Administration of Po^{210} strongly enhances radiation permeability of tissue, while citrin and citrin compounds with unithiol depress the radiosensitivity of tissue and act as protective chemicals against radiation injuries to the histo-hematic barrier in the spleen. (R.V.J.)

1452 ELECTROCARDIOGRAPHIC CHANGES IN RABBITS SUBJECTED TO THE CHRONIC ACTION OF RADIOACTIVE ZINC DURING INTRAVENOUS ADMINISTRATION OF ADRENALINE AND INHALATION OF AMMONIA. V. G. Ovakimov, L. N. Bibikhin, and A. O. Saitanov. Med. Radiol., 8: No. 9, 55-61(Sept. 1963). (In Russian)

The employment of pharmacological loadings (administration of adrenaline and inhalation of ammonia) in rabbits subjected to the chronic action of radioactive zinc (1 and 10 μC/kg) disclosed changes in the sensitivity of adrenoreactive systems of the myocardium (in adrenaline test) and an altered intensity and duration of reflex bradycardia (in ammonia test). (auth)

1453 REDUCTION OF RADIATION MORTALITY THROUGH MAGNETIC PRE-TREATMENT. Madeleine F. Barnothy (Univ. of Illinois, Chicago). Nature, 200: 279-80 (Oct. 19, 1963).

A total of 920 mice of different age and strain were treated in homogeneous and inhomogeneous magnetic fields and then irradiated. Various time-intervals were interposed between the termination of magnetic treatment and irradiation; also treatment after irradiation was tried. In most instances 30 mice were treated in 10 permanent magnets for a period of 14–20 days and the same number of mice housed during the same time in ten dummy magnets. Magnetic pre-treatment of mice in a homogeneous magnetic field of 4200 Oe strength and less than 3 days of delay between the termination of treatment and irradiation decreased the death rate by 24–30%. Leukocytosis following the magnetic treatment did not compensate the leukopenia caused through irradiation: it merely diminished it slightly. The effects of inhomogeneous magnetic fields were not consistent. (P.C.H.)

1454 EFFECT OF BASIC DYES ON HOST-CELL REACTIVATION OF ULTRA-VIOLET-IRRADIATED PHAGE. Rose R. Feiner and Ruth F. Hill(Columbia Univ., New York). Nature, 200: 291-3(Oct. 19, 1963).

Bacteriophages from bacterial hosts E. coli strains B, B/r, B_{s-2}, (host-cell reactivation positive-hcr^+), and B_{s-1} (host-cell reactivation negative-hcr^-) were irradiated and then exposed to crystal violet and acriflavine in the plating media. A decrease in the fraction of the damage that can be repaired was found. Presumably the dyes reduce the accessibility of damage regions to the repair enzyme. Besides this effect, the fraction cells that can repair also decreased. This suggests that bacterial DNA is also necessary for repair and that its action is impaired by the dyes. The results imply that repair by genetic exchange between phage and bacterial DNA occurs and is mediated by a recombinase enzyme. (P.C.H.)

1455 EFFECTS ON IRRADIATED MICRO-ORGANISMS OF GROWTH IN THE PRESENCE OF ACRIFLAVINE. Tikvah Alper (Medical Research Council, London). Nature, 200: 534-6(Nov. 9, 1963).

Investigations were made on the effects of acriflavine on lethal damage induced in microorganisms by ionizing as well as by ultraviolet radiation. Growth curves for E. coli B and E. coli B/r on solid medium incorporating 5 γ/ml acriflavine showed that the initial lag phase was prolonged, but the generation times were unaffected. The most striking characteristic of acriflavine is that it affects all strains in the same sense, the incorporation of acriflavine in the medium bringing additional radiation damage to light. In

every case the effect was greater after ultraviolet than after ionizing radiation, and, with the latter, the treatment was more effective if suspensions were irradiated in anoxic than in aerobic conditions. (P.C.H.)

1456 RADIATION PROTECTION BY CYSTEAMINE AND CELLULAR SULPHYDRYL LEVELS. László Révész and Helena Bergstrand (Karolinska Inst. Medical School, Stockholm). Nature, 200: 594-5(Nov. 9, 1963).

Investigations were made on changes in the trichloroacetic acid extractable, non-protein bound sulfhydryl (NP-SH) content of cells in an Ehrlich ascites tumor line ELD, and in two of its sublines, ELT and SELD clone j, after cysteamine treatment in vitro. It was noted that an increase of the cysteamine concentration in the medium from 1 to 20 mM is associated with a closely uniform, gradual increase of the NP-SH level in all cell lines to nearly 4-fold of the controls. The correlation between the extent of the increase of cellular non-protein sulfhydryl content and radioresistance strongly suggests that the mechanism of radiation protection by cysteamine is dependent on the concentration of the non-protein sulfhydryls, which is established in the protected cell. (P.C.H.)

1457 BLOOD CHANGES IN TOTAL-BODY IRRADIATED ALBINO RATS PROTECTED BY N-PHENYLAMIDINE OF THIOPHENE-2-CARBONIC ACID. D. Zogratov and I. Bayev (Inst. of Radiobiology, Sofia). Radiobiol. Radiotherap., 2: 49-53(1961).

Changes in peripheral blood cell levels were followed in rats exposed to x-ray doses of 600 r, some of which were pre-treated with 10 mg of this compound, previously shown to be radioprotective in mice. This dose proved absolutely lethal for the unprotected animals, which died between the 10th and 24th day, but 80% of the treated animals survived to at least the 30th day. The onset of anemia was more rapid in the unprotected animals; its maximum extent was reached at the same time (14th-17th day) for both groups, but was higher in the unprotected animals (35% of the initial value), and recovery in this group was delayed. Changes in the reticulocyte count were the same in both groups in all phases; they never disappeared from the blood, the maximum drop occurring on the 3rd to the 5th day and the highest level between the 14th and the 25th day. There were no differences in the leukocyte counts; in both groups leukopenia occurred rapidly (32-38% of the initial value) on the first day, reached a maximum on the 5th day, after which recovery proceeded slowly to the 17th day, and then rapidly, so that higher than initial values are reached on the 24th day. Changes in the neutrophil count of both groups followed the same trend; the maximum drop occurred on the 5th day, recovery began on the 7th day, reaching values above the initial level on the 24th day. The lymphocyte counts showed no difference between the two groups. There was a sharp drop on the first day, the maximum was reached on the 5th day, recovery began on the 10th day, and on the 25th day the lymphocytes values above the initial ones were reached. Changes in the monocyte count indicated earlier recovery in the protected animals (after the 3rd day); the maximum drop and recovery after the 10th day were the same. The thrombocyte count drop in the protected animals occurred more slowly, its maximum was the same as that of the control group but lower. The results thus confirmed the protective effect of N-phenylamidine of thiophene-2-carbonic acid and that erythropoiesis in the protected animals was less damaged, as manifested by the slower occurrence and lesser degree of anemia and more rapidly recovered. With regard to erythropoiesis and thrombopoiesis the regenerative processes proceeded identically in the two groups. The protective action, therefore, was attributed to repression of the early physicochemical reactions in the irradiated organism and not to the preservation of the regulatory mechanisms which determine the regenerative processes. The more favorable course of the blood changes was considered not as a cause, but as an effect of the lesser damage to the organism as a whole. (BBB)

1458 THE RADIATION PROTECTION OF SULFHYDRYL COMPOUNDS AND THEIR PARAMAGNETIC PROPERTIES AFTER X IRRADIATION IN RELATION TO THEIR CHEMICAL CONSTITUTION. Ruprecht Koch (Universität, Freiburg i. B.). Strahlentherapie, Sonderbaende, 51: 224-31(1962). (In German)

The relation of chemical constitution to the radioprotective properties of sulfhydryl compounds is discussed. The possibilities by which a chemical compound can produce protection are summarized. The role of paramagnetic properties of the compounds is outlined. (M.C.G.)

1459 CHEMICAL PROTECTION AGAINST IONIZING RADIATION. RADIOCHEMISTRY OR CELLULAR PHYSIOLOGY? Lorentz Eldjarn (Universitetet, Oslo). Strahlentherapie, Sonderbaende, 51: 232-44(1962). (In English)

The protective effects of various chemical compounds against radiation injuries in mammals and isolated cells are reviewed from the point of view of reaction mechanisms involved. It is pointed out that at present there is no fundamental fact concerning chemical protection that can be stated without admitting the existence of exceptions. The role of cellular physiology in radiochemical response is discussed. Emphasis is placed on the metabolic effects that the radioprotective thiols demonstrate. It is postulated that the radioprotective effect of thiols may be mediated by mixed disulfide formation involving cellular enzyme systems. (C.H.)

1460 A NEW TEST FOR CHEMICAL RADIOPROTECTION IN MAMMALS. Z. M. Bacq and M. L. Beaumariage (Université, Liège). Strahlentherapie, Sonderbaende, 51: 245-9(1962). (In English)

The need is discussed for an easy test of chemical radioprotective substances that will indicate the active mechanism of protection. One such test for use in rats or mice exposed to high-level local or whole-body irradiation is the growth or retention of hair at the site of injection of the protective compound. Results are reported from studies in which the protective compound was injected 5 min before the beginning of irradiation. The compounds injected included cysteamine, cysteine, AET, MEG, and histamine. Extensive studies on the radioprotective effects of cysteamine injected intraperitoneally in young rats indicate that anoxia is not the main mechanism of action of cysteamine. (C.H.)

Radiation Hazards and Protection

1461 MEDICAL THERAPY FOR INTERNALLY DEPOSITED RADIOISOTOPES. W. D. Norwood (General Electric Co., Richland, Wash.). Am. Ind. Hyg. Assoc. J., 24: 492-6(Sept.-Oct. 1963). (HW-SA-3004)

Preventive methods are being vigorously pursued in the handling of dangerous radioisotopes. However, the number of accidental depositions may be expected to increase because of the rapid increase in the use of these materials. While considerable work is being done to learn more about

the metabolism of radioisotopes in animals and man, much more remains to be accomplished. General and specific methods are outlined for treating individuals who have inhaled, ingested or received depositions of dangerous radioactive materials through the intact or injured body surface. Considerable progress has been made but continued research is necessary to improve our knowledge in this field. (auth)

1462 FAST NEUTRON GENERATORS: RADIATION LEVELS AND SHIELDING REQUIREMENTS. R. J. Cloutier (Oak Ridge Inst. of Nuclear Studies, Tenn.). Am. Ind. Hyg. Assoc. J., 24: 497-501(Sept.-Oct. 1963).

The radiation hazards from a neutron generator of the Cockcroft-Walton type are manifold; however, the prime hazard is from the neutrons produced by the machine. Neutron shielding requirements are dictated primarily by the $H^2(H^3,n)He^4$ reaction because of its high yield and the penetrability of the 14-Mev neutrons it produces. To reduce the neutron flux from a generator producing 10^{10} neutrons per second to acceptable levels for limited operation, 12 feet of distance that included 27 inches of water and 16 inches of solid concrete block were used. The presence of x-rays produced by electrons accelerated in the evacuated tube in the direction of the target-to-ion source, even when neutrons are not being produced, requires that care be exercised in approaching the generator under these conditions. Tritium released from the target was also noted to present an inhalation problem during maintenance work on the diffusion and fore pump and while changing targets. (auth)

1463 FREE RADICALS INDUCED BY THE γ RADIATION OF Co^{60} IN NUCLEOSIDES: PHENOMENON OF RADIOPROTECTION. Albert Van de Vorst and Claudine Williams-Dorlet (Institut d'Astrophysique, Cointe-Sclessin, Belg.). Compt. Rend., 257: 2183-6(Oct. 7, 1963). (In French)

The yields of free radicals, formed by the action of γ radiation from Co^{60} on nucleosides in the solid phase, were determined, and the isolated components were characterized. The comparison of the results obtained shows a highly effective protective effect of the pentose group by the base. The free radical obtained is located in the base. (tr-auth)

1464 RESEARCH ON DETERMINATION OF THE RADIOISOTOPES Sr^{90} AND Cs^{137} IN SAMPLES OF PLANTS. M. Zanetti and F. Cutrufelli (Università, Bologna and Ufficio di Igiene del Comune, Bologna). Minerva Nucl., 7: 257-60(July 1963). (In Italian)

Results of determinations of the Sr^{90} and Cs^{137} content of 31 plant samples obtained during 1962 are presented. Higher values were found than in 1961. The results also support the hypothesis suggested by other workers that there is a relationship between the rainfall and pollution by radioactive fallout, as well as the fact that absorption of Cs^{137} by the leaves is greater than that of Sr^{90}. (auth)

1465 DOSES OF GAMMA RADIATION AS A CONSEQUENCE OF SKIN CONTAMINATION WITH BETA- AND GAMMA-EMITTING NUCLIDES. F. Breuer and E. Casnati. Minerva Nucl., 7: 289-92(July 1963). (In Italian)

An investigation was undertaken to determine whether or not, in the case of skin contamination from β and γ emitters, it is sufficient to measure the dose received by the skin and underlying tissues simply on the basis of the emission of β particles. An approximate, simplified formula was established for the calculation of photon radiation. The dose delivered to the skin and underlying organs was calculated for certain radioisotopes and in various circumstances. On the strength of the findings it is suggested that account be taken in some cases of γ radiation and that further research must be made on the problem of measuring this type of radiation with greater accuracy. (auth)

1466 THE RISK OF WORK WITH Au-198. J. Kudrna and A. Černohorský. Pracovni Lekar., 15: 294-7(Sept. 1963). (In Czech)

The gamma doses in Au-198 application in patients and from decontamination of the dead, show that the working risk is low, owing to the short exposure time. The short time factor must, however, be emphasized as the level of dose intensity is relatively high, 30-40 mr/hour for the entire body. It is, therefore, necessary to plan all manipulations with radioisotope beforehand in such a way as to reduce the time factor and diminish the risk. All workers must have personal dosimeters, the readings of which are regularly registered and evaluated. Radioactive gold must never be administered to moribund patients. (auth)

1467 V. RADIOBIOLOGICAL AEROSOL PROBLEMS. PROPERTIES AND RISKS OF ATOMIC INDUSTRY RADIOACTIVE AEROSOLS. I. RADIOIODINE (REVIEW REFERENCES). W. Herbst (Universitat, Freiburg i. B.). Zentr. Biol. Aerosol Forsch., 11: No. 3, 232-73(Sept. 1963). (In German)

The properties, distributions, and biological dangers of radioiodine are reviewed along with detection methods and safety. Topics covered include: physical aspects of the genesis of radioiodine, radioiodine in the biosphere and environment, radiobiological toxicity of radioiodine, maximum permissible doses and concentrations as well as radiation protection standards for radioiodine at various risk levels, actual situations of the contamination of the biosphere with radioiodine, and first aid and control. Two hundred and seventeen references are included. (M.C.G.)

Radiotherapy and Radiodiagnosis

1468 THE MODIFICATION OF TISSUE RESPONSE TO RADIATION INJURY. O. C. A. Scott (Mount Vernon Hospital, Northwood Middx., Eng.). Ann. Rev. Med., 14: 371-80(1963).

A survey is made of protection by procedures carried out before irradiation; an attempt is made to examine the logical processes which lay behind the various experiments, rather than the experimental data itself. It is suggested that there has been a tendency for research workers in this field to be divided into separate schools. One began with the demonstration >50 yr ago, that the response of human skin to x rays could be diminished by the application of pressure by means of a vacuum cup, and culminated in the discovery in 1950 that induction of anoxia is an effective method of protecting rats against total-body irradiation. The second trend had its origin in the work of radiochemists in the 1930's that radiochemical reactions, which were brought about by the products of the radiolysis of water, could be modified by simple procedures such as dilution or addition of other solvents, and later discovery of similar effects in biological systems. The separation of these two trends has not been absolute, and other mechanisms of radioprotection have also been considered. The work of Bacq and the Liege School is considered in detail. The anoxia hypothesis is often referred to in the literature of chemical protection, but there appears to be confusion as

to its exact nature and limits. Two mechanisms had been suggested which related chemical protection to anoxia: pharmacological effects in vivo, and simple chemical removal of oxygen in vitro. It has been postulated that some protective drugs produce partial anoxia in vivo to explain many of the observed results, and it has appeared reasonable to suggest that all drugs, including those of the sulfhydryl group, act via anoxia, at least as far as the protection of mammalian tissues is concerned. Careful examination of the arguments brought forward in support of the anoxia hypothesis (as applied to mammalian tissues) shows that they are not as conclusive as they once appeared to be. The reversal of cysteine protection by oxygen under pressure does not prove that cysteine causes anoxia; this result is also compatible with the theory that oxygen and the protective agent are competing for interaction with a damaged site. Even so, the anoxia theory has fared better than the radical scavenger theory in that the majority of pharmacologically active compounds probably act in this way in vivo, and it is wise to eliminate anoxia as a possible cause when a drug is given in such high doses as to cause death in unirradiated controls. Also, sulfhydryl compounds do remove oxygen from solution, and this removal probably provides the explanation of some results. Drugs of the cysteine-cysteamine group can cause anoxia in a mammal if given in high enough doses; thus, both the mechanisms relating sulfhydryl compounds and anoxia which were suggested do, in fact, operate, but it now appears that a third pathway, not related to anoxia, may be a vital one both in vivo and in vitro. In this third theory, the cysteine-cysteamine group of agents act primarily by the formation of mixed disulfides with tissue proteins. This hypothesis is more limited than either of the two so far considered, in that it is restricted to this one class of protectors. Factors supporting this hypothesis are pointed out. It is concluded, with respect to the mechanism of action of chemical protectors in vivo, that the majority of the pharmacologically active drugs, such as the amines, act by bringing about a state of tissue hypoxia. The cysteine-cysteamine-AET group, on the other hand, although they can cause anoxia in some systems, have a protective action which is not entirely attributable to anoxia, and which is most readily explained in terms of healing of damage in a target molecule. (BBB)

1469 RADICAL SURGERY AFTER INTENSIVE HIGH-ENERGY IRRADIATION. Theodore Ditchek and Isadore Lampe (Univ. of Michigan, Ann Arbor). Arch. Surg., 86: 534-9(Apr. 1963).

Radiation treatment of cancer usually has been reserved for surgical failures rather than use of radiation initially, and many surgeons attribute any postoperative complication occurring in or near an irradiated area to radiation effects. However, with the newer radiation techniques, the damage to vasculoconnective tissue can be greatly reduced, leading to less delay in wound healing and less postoperative morbidity. Thus, many therapists and a few surgeons now report that the postoperative morbidity after competent irradiation differs little from that of the surgical procedure alone. To determine the risks involved in major surgery following intensive high-energy radiation, 50 patients with head and neck carcinoma treated with Co^{60} γ radiation, and subsequently undergoing radical surgery in the irradiated area, were studied. All patients received a 6000- to 7000-r tumor dose in 6 to 7 weeks. In all 50 cases, at least the major portion of the operative field was in irradiated tissue, and in ~half of the cases, the irradiated volume took in the entire operative field (radical neck dissection). Only 5 cases of postoperative sequelae of a severe nature were encountered, and are discussed in detail. While the highest incidence of complications occurred after 4-6 months, it was felt that the sample was too small for a definitive statement concerning the best time for surgery. Difficulties encountered during the surgical procedure itself may be classified into 2 groups: problems of dissection, which occurred in 10 patients (20%), ranging from minimal stickiness of tissues to difficulty in starting a fascial plane; and excessive bleeding or oozing in 4 cases (8%). It is concluded that the complication rate in the group reported here is not significantly higher than that associated with the radical surgical procedures alone. The technical difficulties encountered during surgery were usually minor and did not limit the surgery in any manner. Thus there is little additional risk in performing radical surgical procedures in an area competently irradiated, providing that the radiation dose has been fractionated properly and that high-energy radiations have been utilized. (BBB)

1470 A DEVICE FOR INTRAPERITONEAL (INTRAPLEURAL) APPLICATION OF COLLOIDAL RADIOGOLD (^{198}Au). V. Vebersík (Charles Univ., Prague). Atompraxis, 9: 412-14(Oct. 1963). (In German)

A simple device for intraperitoneal or intrapleural application of colloidal radiogold is described. Radiation protection during the infusion of Au^{198} is afforded by a special double-walled tube, with a filling of tiny lead pellets in between the walls. The attenuation coefficient μ was determined for three different pellet sizes in relation to gamma energies of 0.1 to 3 Mev, as well as the percentual gamma-radiation absorption of the radiogold in relation to wall thickness. (auth)

1471 A STUDY OF THE RELATIVE VALUE OF RADIOACTIVE SUBSTANCES USED FOR BRAIN TUMOR LOCALIZATION AND OF THE MECHANISM OF TUMOR: BRAIN CONCENTRATION UPTAKE IN TRANSPLANTABLE FIBROSARCOMA, BRAIN, AND OTHER ORGANS IN THE RAT. Christine M. E. Matthews and G. Molinaro (Hammersmith Hospital, London). Brit. J. Exptl. Pathol., 44: 260-77(June 1963).

An evaluation was made of the ability of different isotopes, injected intravenously, to give a higher concentration in brain tumors and other pathological cerebral tissues than in normal brain tissue. Thus, a comparison was made of various isotopes and labeled substances in the same system, to determine which could be expected to give the best results in patients, and to find out more about the mechanism of the method. Uptake of the radioactive substances was measured at different times after injection, in brain, tumor and other organs in rats with subcutaneous transplanted fibrosarcoma. Each radioactive substance was investigated in only a few animals as these experiments were intended to detect large differences between substances, and not to obtain accurate values of organ concentrations or extracellular spaces. Bi^{206} gives much higher tumor brain concentration ratios than any other isotope tested. This can be accounted for by considering that it is an intracellular ion which is rapidly cleared from the blood and which enters brain slowly. Its low concentration in muscle and blood makes this isotope especially suitable for brain tumor localization. Br^{82}, Ga^{68}, Zr^{95}, Sb^{122}, I^{131}, I^{131}-iododeoxyuridine, Ag^{*}, Nb^{95}, and I^{131}-human serum albumin behave as extracellular substances up to the times studied (2 days), and equilibrate with the extracellular spaces of tumor and brain. These substances therefore all give a tumor/brain concentration ratio of about 8-25 : 1 (except Br^{82}, which probably enters brain cells). For these sub-

stances, tumor and brain concentrations are roughly proportional to blood concentration. The Ag^{*} used consisted of Ag^{105}, Ag^{106}, Ag^{110}, and Ag^{111}. K^{43}, Rb^{84}, Zn^{65}, Hg^{203} (as neohydrin), Bi^{206} and Mn^{52} behave as intracellular substances. Their concentrations in tumor do not vary greatly and are independent of blood concentration. In brain their concentrations are roughly proportional to blood concentration. The tumor/brain concentration ratio therefore varies with blood concentration and is greatest for those which are rapidly cleared from the blood, such as Bi^{206}. These results are consistent with two possible explanations for the blood-brain barrier: that it is due to both lack of extracellular space and to reduced cell permeability or uptake in the brain, and that it is due to a physical barrier impermeable to extracellular substances but slowly permeable to intracellular substances. As^{74} is concentrated by red cells in rats, but not in man. In rats nearly all the radioactivity is in the blood several hr after injection. The concentration in kidney is also high, and the lowest concentrations are in the brain, muscle, and intestine. When the effect of increasing the amount of carrier injected was investigated, for K^{43} there was no effect, since stable K is already present. For arsenite there was no significant effect, but with arsenate the addition of carrier greatly reduced red cell uptake and kidney concentration and increased excretion, since both tumor and brain concentration were reduced. For Ag^{*} and Bi^{206} nitrate, addition of carrier causes precipitation of AgCl and $BiONO_3$, respectively, and hence increased uptake by the reticuloendothelial system. For Bi^{206} nitrate this reduced tumor uptake considerably with little effect on brain uptake. Bi^{206} citrate is more soluble, and addition of carrier did not cause precipitation, and therefore reduces tumor uptake to a much smaller extent. With Ag^{*}, tumor uptake appeared to increase by addition of carrier, while brain uptake was decreased. (BBB)

1472 A RADIOIODINE DISPENSER. H. I. Glass, J. L. Holden, D. Rowan, and W. Stevenson (Western Regional Hospital, Glasgow). Brit. J. Radiol. 36: 855-7(Nov. 1963).

The principal hazards associated with dispensing radioiodine for routine thyroid therapy are those due to external gamma radiation and ingestion. A radioiodine dispenser designed around a modified Baird and Tatlock Analmatic pipette is described. The dispenser is required to handle up to 200 mC each week. Minimization of operator hazard and elimination of ingestion risk are emphasized in the design. (H.M.G.)

1473 RADIOISOTOPE PLACENTOGRAPHY: A BEDSIDE PROCEDURE. Millard N. Croll, Larry H. Shuman, Leonard Stanton, and Casimir Czarnecki (Hahnemann Medical Coll., Philadelphia). J. Nucl. Med., 4: 417-25(Nov. 1963).

Localization of the human placenta by a radioisotopic method utilizing I^{131} human serum albumin is reliable, safe, and convenient. The accuracy of localization of the placenta has been excellent. Determination of clinically suspected placenta previa was correct in 92.3% (12 of 13 patients). Radiation dosage to the maternal abdomen and gonads and fetal whole-body radiation dosage have been reduced far below what is received by the usual roentgenographic study. The procedure is a truly bedside examination with lightweight portable equipment and precalibrated doses of the radioisotope. (auth)

1474 EXTRAPOLATION OF PRECORDIAL COUNTING CURVES. Ralph J. Gorten and Harry M. Hughes (School of Aerospace Medicine, Brooks AFB, San Antonio, Tex.). J. Nucl. Med., 4: 485-6(Nov. 1963).

The use of γ emitters and precordial counting for determination of cardiac output precludes the need for intra-arterial sampling, and the calculations can be relatively quickly accomplished. The time required for the procedure is minimized by direct inscription of the precordial indicator dilution curve on rectilinear chart paper and determination of the area under the curve by tracing its perimeter with a polar planimeter. For use in the formula for cardiac output, this figure must include only the area under the primary circulation curve; therefore the inscribed downslope must be extrapolated from the start of recirculation down to pre-injection baseline. An inexpensive device for the accurate, reliable, and rapid extrapolation of directly recorded precordial curves is described. (auth)

1475 MORPHOLOGICAL OBSERVATION ON AUTOPSY CASES OF LEUKEMIA, APLASTIC ANEMIA, AND CARCINOMA TREATED BY BONE MARROW INFUSION. Kazuo Hizawa (Tokushima Univ., Japan). Nippon Ketsueki Gakkai Zasshi, 24: 682-8(Dec. 1961). (In Japanese)

Autopsy findings in the cases of leukemia, aplastic anemia, and carcinoma treated by irradiation and homologous bone marrow infusion are reported. Patients with leukemia and carcinoma were treated with Co^{60} irradiation or cytostatic chemotherapy prior to the bone marrow infusion. Two cases of acute leukemia showed prominent decrease at autopsy in intensity of the leukemic infiltration in bone marrow, spleen, liver, lymph nodes, and organs. It seemed likely that the preliminary treatment induced a remission in leukemia; however, evidence of active hematopoiesis confirming a successful transplantation was not attained. In the one case of pulmonary cancer, the intensively irradiated sternal marrow was completely acellular. On the other hand, bone marrow of the lumbar vertebrae was only slightly hypocellular, showing almost normal hematopoiesis. The lumbar marrow was not as severely injured by radiation as sternal marrow. The bone marrow in a case of gastric cancer was extensively destroyed by an osteoplastic metastases. The spleen was also almost completely destroyed by a metastasis and anemic infarction but evidence suggesting proliferation of the infused cells was not found. Megakaryocytes were also demonstrable without association of hematopoietic cells in the capillaries of lung, sinusoids of liver, spleen, and lymph nodes only in cases which died within a short time after the last marrow infusion. Definite extramedullary hematopoiesis was not observed in any case, nor was pulmonary infarction, as a result of bone marrow infusion, detected in any case. (BBB)

1476 A SPATIAL MODEL OF TIME-DOSE-AREA RELATIONSHIPS IN RADIATION THERAPY. Carl F. von Essen (Yale Univ., New Haven). Radiology, 81: 881-3(Nov. 1963).

A three-dimensional model depicting time-dose-area relationships is described. The model demonstrates the relationships of overall time, cumulative radiation dose, and tissue area to normal and malignant tissue responses. It serves as a useful teaching tool as well as a practical clinical guide in radiation therapy of superficial skin cancer. (auth)

1477 APPLICATIONS IN MEDICINE. p.97-113 of "Isotopes and Radiation Technology. Vol. 1, No. 1."

A review is presented of recent developments in medical uses of radioisotopes. Both diagnosis and therapy are covered, and the various isotopes of iodine and other elements are discussed. The world distribution of teletherapy sources is tabulated. (D.L.C.)

1478 ELECTRON THERAPY AND ELECTRON-BIOLOGICAL EXPERIMENTS. Umberto Cocchi (Universität, Zurich). Strahlentherapie, Sonderbaende, 51: 295-303(1962). (In German)

The use of fast electrons with energies between 22 and 30 Mev for radiotherapy is discussed. The surface dose from fast electrons amounts to about 90 to 95% of the maximum value, which appears at depths of ½ to 5 cm. The questions of biological effects and dosimetry are considered. Examples of electron therapy of carcinomas of the tongue, tonsils, oral cavity, and lymph nodes are described. (M.C.G.)

1479 RELATIONSHIP BETWEEN RELATIVE BIOLOGICAL EFFICIENCY AND THERAPEUTICAL EFFICIENCY OF HIGH ENERGY RADIATIONS. Luigi Turano (Università, Rome). Strahlentherapie, Sonderbaende, 51: 304-11(1962). (In English)

The relation between the relative biological efficiency and linear energy transfer was compared in mice exposed to 150-kev x rays. Co^{60} γ radiation, and electron beams of 6 and 15 Mev. Effects on total body weight and fresh and dry weight of organs were used as criteria. An analysis was also made of recovery after administration of 150 kev x rays and 15 Mev electrons as demonstrated in radioautograms obtained by the introduction of tritium-labeled thymidine into the thymus. Results are discussed. It was concluded that the therapeutical improvement offered by high-energy radiations in relation to conventional x rays is based on radiobiological as well as technical reasons. (C.H.)

1480 THE MANAGEMENT OF THYROID CARCINOMA — THE ROLE OF RADIO-IODINE (I-131). Joseph B. Workman (Univ. of Maryland and University Hospital, Baltimore). 8p. (CONF-164-10)

From Society of Nuclear Medicine 10th Annual Meeting, Montreal, June 1963.

Experience from the management of 156 patients with proven thyroid cancer, followed from 1 to 11 years, is reported. Although no sweeping conclusions can be drawn, it appears that radioiodine continues to have a place in the overall management of most cases of this malignant disease. (auth)

CHEMISTRY

General

1481 (ANL-6671) DENSITY MEASUREMENTS IN GLOVEBOXES. WITH DENSITY DATA ON MONOBROMOBENZENE, CAST THORIUM, THORIUM–URANIUM, AND THORIUM–PLUTONIUM ALLOYS. B. Blumenthal (Argonne National Lab., Ill.). Sept. 1963. Contract W-31-109-eng-38. 29p.

By taking into consideration temperature differences between the glovebox atmosphere and the liquid, it was possible to make density measurements in gloveboxes by the hydrostatic weighing method with monobromobenzene as a liquid with an accuracy of ±0.005 g/cm^3. This is an improvement by an order of magnitude over the prior state. This accuracy allows structural changes to be detected in thorium–uranium and thorium–plutonium alloys. (auth)

1482 (ANL-6687) CHEMICAL ENGINEERING DIVISION SUMMARY REPORT, JANUARY–MARCH 1963. (Argonne National Lab., Ill.). Contract W-31-109-eng-38. 204p.

Progress is reported in six sections on chemical-metallurgical processing, fuel cycle applications of volatility and fluidization techniques, calorimetry, reactor safety, energy conversion, and routine operations. Separate abstracts were prepared for the first five sections. (D.L.C.)

For abstracts of individual sections see: 1483, 1484, 1485, 1486, and 2569.

1483 (ANL-6687(p.27-85)) CHEMICAL-METALLURGICAL PROCESSING. (Argonne National Lab., Ill.).

Pyrometallurgical development is reported on melt refining, processes utilizing liquid metal solvents, and reactor materials. The status of the fuel cycle facility for fuel processing at EBR-II is discussed, and the development of service and process equipment is described. Investigations of liquid metals to provide data for use in design of fuel reprocessing methods and in the development of the technology of liquid alkali metals, are reported. (D.L.C.)

1484 (ANL-6687(p.86-152)) FUEL CYCLE APPLICATIONS OF VOLATILITY AND FLUIDIZATION TECHNIQUES. (Argonne National Lab., Ill.).

The development of a direct fluorination volatility process for the recovery of U and Pu from irradiated fuels was continued. Both laboratory- and engineering-scale studies were carried out. The possibility of decladding stainless steel-clad UO_2 pellets by oxidation was investigated. The reactions of PuF_6 and UF_6 were studied. Process studies were made on the processing of enriched U–Zr alloy fuels. Finally, the conversion of UF_6 to high-density UO_2 by reaction with steam and H_2 was studied. (D.L.C.)

1485 (ANL-6687(p.153-66)) CALORIMETRY. W. N. Hubbard and W. M. Feder (Argonne National Lab., Ill.).

A program is being conducted to determine thermodynamic data for many compounds of interest in high-temperature chemistry. Studies described include these on the combustion of Zn, Nb, Ta, Ru, C, and SiC in F_2, on the U–S system, and on two high-temperature enthalpy calorimeters. (D.L.C.)

1486 (ANL-6687(p.167-87)) REACTOR SAFETY. (Argonne National Lab., Ill.).

The oxidation, ignition, and combustion of reactor materials are being studied to provide information for minimizing the handling hazards. The studies described include oxidation of U and Pu, and reactions of metals with water. (D.L.C.)

1487 (HW-77609(Sect.3)) RADIOLOGICAL CHEMISTRY. (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). 106p.

Data are presented from preliminary measurements of radioisotope yields from the thermal neutron fission of Pu^{239} and Pu^{241}; studies on the effects of chemical additives and coating materials on the reduction of radionuclides in reactor effluent water; the determination of Th^{232} in urine by activation analysis; a bioassay procedure for Pm^{147}; the measurement of Cl^{38} and W^{187} in reactor effluent water; the separation of As^{76} from reactor effluent water; the determination of P^{32} in river sediments; revision of a fluorescein analysis technique for use in atmospheric diffusion studies using ZnS as a tracer; liquid scintillation counting of tritium; estimations of fast neutron doses from the Hanford criticality accident; and the development of methods for sampling fallout from air at ground level and from aircraft. Data are included on the levels of radionuclides from fallout and other sources in air, stack gases, and Columbia River water and sediments in the Hanford area during 1961 and 1962. High sensitivity analytical methods were developed for the quantitative measurement of U^{238}, U^{234}, Th^{230}, Ra^{226}, Po^{218}, and Po^{210} in biological samples. Results are included from studies of the radiation chemistry of the dyes erioglaucine and tropeoline; the effects of temperature on radical-capturing reactions in irradiated aqueous solutions; radical-capturing reactions of galactose and agarose in irradiated solutions; the kinetics of radioinduced hemolysis of human red blood cells in aqueous suspensions; electrophoresis patterns of sera from irradiated and normal persons; and the low noise modification of an electron spin resonance spectrometer. (C.H.)

1488 (IDO-11055) ORGANIC COOLANT RECLAMATION AND COOLANT CHEMISTRY. Annual Report No. 4, December 15, 1961–December 14, 1962. Daniel A. Scola, John S. Adams, Charles C. Richiusa, and Ralph Kafesjian (Monsanto Research Corp. Boston Labs., Everett, Mass.). May 10, 1963. Contract AT(10-1)-1088. 130p.

Results of exploratory research and development on organic coolant reclamation and coolant technology to develop an economical process to reclaim decomposed terphenyl coolant are described. The solvent treatment method for reclaiming high boiler was further refined to include OMRE core IIIA high boiler and spent coolants with varying high boiler concentrations. Centrifugation was shown to be a good technique for separating the soluble and insoluble fractions. Results from electron radiolysis and reactor irradiation of reclaimed high boiler and spent coolant showed that reclaimed coolants have good radiation resistance. Hydrocracking of high boiler was demonstrated to be a feasible reclamation process. Several alkylpolyphenyls were prepared and their thermal and radiolytic stability were measured. The reaction rate constants for the thermal decomposition at 350, 427, 482,

and 510°C were determined. Economic comparisons of reclamation processes indicated that the solvent treatment process is the most economical of the processes that are demonstrated to be technically feasible. (M.C.G.)

1489 (IS-700(Sect.C)) CHEMISTRY DIVISION. (Ames Lab., Ames, Iowa). 113p.

Research and development progress is reported on physical and inorganic chemistry, pyrometallurgy, analytical chemistry, spectrochemistry, radiochemistry, and structural chemistry. (M.C.G.)

1490 (ORNL-3488) CHEMISTRY DIVISION ANNUAL PROGRESS REPORT FOR PERIOD ENDING JUNE 20, 1963. (Oak Ridge National Lab., Tenn.). Oct. 25, 1963. Contract W-7405-eng-26. 151p.

Separate abstracts are presented for the ten sections of the report. (N.W.R.)

For abstracts of individual sections see: 1491, 1613, 1614, 1615, 1711, 1725, 1787, 1788, 1789, 1949, 1950, 1951, 2127, 2145, 2146, 2181, 2231, 2841, 3099, 3135, and 3390.

1491 (ORNL-3488(p.102-22)) CHEMICAL PHYSICS. (Oak Ridge National Lab.).

Parameters are reported for an axially symmetric spectrum in gamma-irradiated KNO_3, and the spectrum is identified with NO_3. This species is produced in high yield by short intense irradiations at 77°K. The spectrum disappears in about 2 hr at 77°K. A paramagnetic species in irradiated single crystals of dimethylglyoxime was identified as a ground-state triplet. Hyperfine structure from two equivalently or nearly equivalently coupled nitrogen atoms is present. Five distinct paramagnetic resonance spectra were observed in single crystals of hydrogen peroxide after photolysis with uv. Measurements were made on a species formed in high yield upon photolysis at 64°K. This species is not stable at 77°K. Of two species formed in small yield, one has an extremely large anisotropy in g and the other is clearly a triplet-state species. A neutron-diffraction study of single crystals of XeF_2 and XeF_4 gave accurate parameters for their molecular spacings. Anisotropic thermal analysis indicated similar libratory motion of the molecular species in these molecular crystals. The crystal and molecular structure of sucrose ($C_{12}H_{22}O_{11}$) was determined. The conformation of the furanose ring differs from that known to exist in sucrose·NaBr·$2H_2O$. Hydrogen bonds (two of them intramolecular) utilize every hydroxyl group except one. Some programs for the IBM 7090 computer were written as needed in the structure analyses of chloral hydrate and sucrose. The crystalline phase reported elsewhere as a "high-density form of XeF_4" is shown, by crystal structure analysis, to be a distinct compound with the composition $XeF_2 \cdot XeF_4$. Initial attempts to describe the x-ray scattering from molten CsCl in terms of a model were made. A study of the structure of the cubic phase of CaC_2, stable above 450°C, is nearly complete, and the results strongly favor a pyrite arrangement disordered with respect to the orientation of the C_2 anions. A study of the structure of aqueous NH_4F solutions is currently in progress. There are four anomalies in the heat capacity data on K_2ReCl_6. Also, anomalies in the thermal expansion coefficients were observed accompanying the heat capacity anomalies in the liquid-nitrogen region. A commercially available Polaroid film holder was extensively modified for use in x-ray and neutron diffraction. An anomaly near 15°K resembling a Schottky anomaly was observed in the heat capacity of $ReCl_3$. The anomaly is discussed in relation to the magnetic susceptibility. The data give 29.59 cal deg^{-1} (mole $ReCl_3)^{-1}$ for the entropy at 298.15°K. The study of interactions between gases and surfaces was continued with an improved apparatus. Special use was made of mass spectrometry to obtain data on ions that result as the direct consequence of nuclear decay. (auth)

1492 (TID-19592(Sect.VII)) SOLUBILITY OF CO_2 IN AMINE SOLUTIONS. E. Fischbach and S. Golub (Columbia Univ., New York). 3p.

Results are reported of determinations of the solubilities of CO_2 in aqueous, menthanol, and chloroform solutions of amines, and in methanol and chloroform. The amines included monoethanolamine, diethanolamine, triethanolamine, methylethanolamine, dimethylethanolamine, methyldiethanolamine, propylamine, triethylamine, and trishydroxymethylaminomethane. (D.L.C.)

1493 EXCITED STATES OF A LINEAR MOLECULAR CHAIN CONTAINING AN IMPURITY. Kanji Katsuura (Tokyo Univ.) and Mitio Inokuti. J. Phys. Soc. Japan, 18: 1486-94(Oct. 1963).

One-dimensional models for coupled molecular chains containing an impurity or displaced molecule are proposed, and properties of their excited states are examined. The eigen energies of the excited states are shown to form a band with a particular level separated downward from the bottom and/or another one upwards from the top of the band. The separations of the top or bottom level from the band edge are calculated for particular cases, and the implications of the results for radiation chemistry are discussed. (auth)

Analytical Procedures

Refer also to abstracts 1344 and 1942.

1494 (AE-124) SIMULTANEOUS DETERMINATION OF 30 TRACE ELEMENTS IN CANCEROUS AND NON-CANCEROUS HUMAN TISSUE SAMPLES WITH GAMMA-RAY SPECTROMETRY. K. Samsahl, D. Brune, and P. O. Wester (Aktiebolaget Atomenergi, Stockholm). Oct. 1963. 23p.

The following trace elements were quantitatively determined by gamma spectrometry in seven samples of non-cancerous and five samples of cancerous human tissue: P, Ca, Cr, Fe, Co, Cu, Zn, As, Se, Br, Rb, Mo, Ag, Cd, Sb, Cs, La, Au, and Hg. In some of the samples the following elements were qualitatively determined: Ti + Sc, Ga, Sr, In, Ba, Ce, Hf, Os, Pt, and U. Most of the trace elements were found to be present in much higher concentrations in the non-cancerous than in the corresponding cancerous liver samples. In a typical run one sample each of cancerous and non-cancerous tissue was irradiated together with standards of the elements to be determined in a thermal flux of 2.10^{13} n/cm^2 sec for 24 hours. The radioactive trace elements were separated into 16, and in some cases 18, groups by means of a chemical group separation method. Subsequently, the gamma spectrometric measurements were performed. Two persons can manage the chemical separations and measure the different activities from a run in 1.5 days. A new method of comparing unknown samples with standards was developed. (auth)

1495 (AERE-AM-96) THE DETERMINATION OF STRONTIUM:CALCIUM RATIOS IN THE ASH OF HUMAN BONES AND TEETH BY DIRECT FLAME PHOTOMETRY. M. L. Wordingham (United Kingdom Atomic Energy Authority. Research Group. Chemistry Div., Woolwich Outstation, England). Oct. 1963. 8p.

Samples of bone or tooth ash are dissolved in dilute

hydrochloric acid and the strontium : calcium ratio is determined directly by flame photometry using an oxygen–propane flame, surrounded by a mantle of oxygen to minimize the suppressing effect of phosphate. The effective concentration range is 20 to 1000 ppm of strontium with respect to calcium. The standard deviation, which remains constant over the effective concentration range, is 10 ppm of strontium with respect to calcium. There is no observed bias. (auth)

1496 (CEA-2285) DOSAGE DU LITHIUM, DU RUBIDIUM ET DU CESIUM DANS LES ROCHES PAR SPECTROPHOTOMETRIE DE FLAMME. (Determination of Lithium, Rubidium, and Cesium in Rocks by Flame Spectrophotometry). R. Pouget (France. Commissariat à l'Énergie Atomique. Centre d'Études Nucléaires, Fontenay-aux-Roses). 1963. 6p.

After sulfohydrofluoric attack of rock, and quantitative estimation of Na and K, the end solution is brought to 10% in Na_2O and K_2O in order to prepare it under the same conditions as standards. Interfering ions are precipitated with calcium carbonate. Flame spectrophotometry is conducted with an hydrogen–oxygen flame. Limits of detection are: 2×10^{-6} g for Li, 4×10^{-6} g for Rb, and 6×10^{-6} g for Cs. (auth)

1497 (CEA-2324) MESURE D'UNE ACTIVITE DE ^{58}Co EN PRESENCE D'UNE ACTIVITE EN ^{60}Co 10^3 À 10^4 FOIS SUPERIEURE. (Measurement of a Co^{58} Activity in the Presence of a Co^{60} Activity 10^3 to 10^4 Times Greater). Simonet and Riegert (France. Commissariat à l'Énergie Atomique. Centre d'Études Nucléaires, Saclay). 1963. 13p.

Described is an experimental method for the measurement of a Co^{58} activity in the presence of a Co^{60} activity which is 1,000 to 10,000 times as great. The determination of this activity is based on the presence of a coincidence between the β^+ particle (whose presence is shown by annihilation γ rays) and the 805 kev γ radiation emitted during the desintegration of Co^{58}. (auth)

1498 (CEA-2352) MEASURES ABSOLUES DE RADIOELEMENTS EMETTEURS GAMMA PAR SPECTROMETRIE. (Absolute Measurements of γ-Ray Emitter Radioelements by Spectrometry). J. Chabert (France. Commissariat à l'Énergie Atomique. Centre d'Études Nucléaires, Grenoble). 1963. 20p.

The proposed apparatus is composed of a lead collimator and a thallium sodium iodide activated scintillation detector. The geometrical solid angle is determined by the collimator, but the real solid angle is larger owing to the γ-ray filtration in the inner sides. The filtration coefficient to apply for obtention of the counting rate corresponding to the geometrical solid angle has been calculated and measured experimentally. γ rays are scattered in the shielding of the scintillator and as a consequence increase the counting rate. The scattering coefficient to apply for obtaining the real counting rate has been measured experimentally. The device efficiency for different γ-ray energies has been calculated and measured experimentally. A certain quantity of γ-ray emitter radioelements have been measured. The accuracy is 4 per cent. (auth)

1499 (CONF-285-3) X-RAY FLUORESCENCE SPECTROGRAPHIC DETERMINATION OF ZIRCONIUM AND MOLYBDENUM IN THE PRESENCE OF URANIUM. E. A. Hakkila, R. G. Hurley, and G. R. Waterbury (Los Alamos Scientific Lab., N. Mex.). [1961]. Contract W-7405-eng-36. 26p.

From 7th Conference on Analytical Chemistry in Nuclear Technology, Gatlinburg, Tenn., Oct. 1963.

Zirconium and molybdenum in uranium-zirconium-molybdenum carbide are determined without chemical separation using an x-ray fluorescence spectrographic procedure. The mixed carbide is dissolved in nitric-hydrofluoric acid, niobium is added to serve as an internal standard, and the solution is irradiated using a tungsten-target x-ray tube. The ratios of the intensities of the Kα lines for zirconium and niobium and of the Kβ lines for molybdenum and niobium are measured. Corrections, which were found to be a linear function of uranium concentration in the range between 30 and 100 percent of uranium, are applied to each intensity ratio. The procedure is applicable to the determination of 5 to 50 percent each of zirconium and molybdenum with a relative standard deviation of 1 to 2 percent. Foreign elements of high mass absorption coefficient interfere when present in concentrations greater than approximately 10 percent for the determination of molybdenum, or 20 percent for the determination of zirconium. (auth)

1500 (EUR-467.f) UTILISATION DANS L'ANALYSE PAR ACTIVATION DE RADIOISOTOPES AYANT DES LOIS DE FORMATION ET DE DECROISSANCE COMPLEXES. (Use of Radioisotopes Having Complex Formation and Decay Schemes in Activation Analysis). F. Girardi, G. Guzzi, and J. Ley (European Atomic Energy Community. Nuclear Research Center, Ispra, Italy). 1963. 29p.

The growth and decay curves of radioisotopes formed by double beta decay or isomeric transition have been studied with a view to using these isotopes in activation analysis without the necessity of irradiating a standard each time. Two FORTRAN programs have been set up and an electronic computer IBM 7090 has been used for the calculations required. The most interesting cases from an analytical standpoint have been discussed. A few of the complex decay curves have been reported for the most usual experimental conditions. (auth)

1501 (LADC-5922) DETERMINATION OF PLUTONIUM IN URINE BY ANION EXCHANGE. Evan E. Campbell and William D. Moss (Los Alamos Scientific Lab., N. Mex.). [1963]. Contract W-7405-eng-36. 16p. (CONF-212-5)

From 9th Annual Bioassay and Analytical Chemistry Conference, San Diego, Oct. 1963.

Pu is concentrated from urine by coprecipitation with alkaline earth phosphates. The precipitate is dissolved in 7.5 N HNO_3, and the Pu absorbed from that solution onto Dowex 1 × 2 anion exchange resin. Interfering anions absorbed on the column are removed with 12 N HCl. The Pu is eluted from the column with specially prepared HCl and HI, and the alpha activity determined by direct planchetting or by electrodeposition of the eluate, followed by standard alpha counting techniques. The problems associated with the determination of Pu in urine are discussed and the advantages of the method presented over other procedures are described. The recovery of 1.6 d/m of Pu from a liter of urine is 86 ± 7.8%. (auth)

1502 (MCW-1477) CONTINUOUS STREAM ANALYSIS OF URANIUM SOLUTIONS BY X-RAY FLUORESCENCE. Topical Report. W. C. Stoecker (Mallinckrodt Chemical Works. Uranium Div., Weldon Spring, Mo.). Nov. 15, 1963. Contract W-14-108-eng-8. 15p.

Experiments were made to develop a continuous stream analysis of uranium solutions by x-ray fluorescence spectrography. The apparatus consisted of a standard x-ray spectrograph, a suitable flow cell constructed of Plexiglas,

a mixing reservoir, and a pump. The cell was connected to the reservoir and pump by means of about 35 feet of Tygon tubing. Changes in concentration of uranium were measured by continuous chart recordings of the uranium Lα total peak intensity. At a flow rate through the cell of 600 ml/min, changes in uranium concentration in the reservoir were recorded on the chart in about 20 seconds. Experiments showed that peak-to-background ratios could be used to provide an accurate measure of concentration changes independently of instrumental and other variables. Continuous analysis was also found to be applicable to the determination of total uranium in raffinate slurries where some of the uranium is present in the suspended solids. (auth)

1503 (NP-13261(p.259-96)) TYPICAL ANALYTICAL PROCEDURES FOR THE DETERMINATION OF URANIUM IN IRON AND STEEL ALLOYS. J. C. Ingles, J. B. Zimmerman, and J. L. Horwood (Canada. Dept. of Mines and Technical Surveys. Mines Branch).

The investigation and production of uranium-bearing steels and alloys presupposes accurate and convenient techniques for the analysis of uranium. Recommended procedures for fluorimetric, radiometric, x-ray emission spectrometric, volumetric, and colorimetric techniques are presented in summary form as an aid for researchers in this field. (auth)

1504 (NP-13271) SIMULTANEOUS QUANTITATIVE DETERMINATION OF FREE ACID AND URANIUM(VI) IN AQUEOUS AND ORGANIC SAMPLES BY DIFFERENTIAL POTENTIOGRAPHIC TITRATION IN NON-AQUEOUS MEDIUM. T. Erben, L. Gehem, and E. Vervecken (European Company for the Chemical Processing of Irradiated Fuels, Mol, Belgium). Jan. 3, 1962. 12p. (ETR-136)

A reasonably accurate and very fast method is described for determining simultaneously the free acid and uranium(VI) either in aqueous or organic (TLA, TBP) solutions. An aliquot of the solution is mixed with acetone and titrated with standard NaOH, and the differential potentiometric titration curve is recorded. The amounts of acid and uranium are calculated by means of calibration curves relating these amounts to the position of the peaks on the titration curves. Thousands of samples were analyzed successfully by this method, so far only for Eurochemic studies. It is believed that the method will also be of great practical value in future routine analyses of the plant for samples in which interference from other hydrolysable ions is negligible. (auth)

1505 (ORNL-TM-724) A LITERATURE SURVEY OF SENSITIVE METHODS FOR THE DETERMINATION OF DISSOLVED GASES AND IMPURITIES IN REACTOR COOLANT WATER. L. E. Scroggie (Oak Ridge National Lab., Tenn.). Nov. 11, 1963. Contract W-7405-eng-26. 11p.

A literature survey of sensitive methods for the determination of dissolved hydrogen, oxygen, hydrogen peroxide, chloride, nitrate, sulfate, aluminum, beryllium, iron, copper, and fission products in reactor coolant water is presented. Sensitivities and precisions of the methods are tabulated. (auth)

1506 (PG-Report-451) ANALYTICAL METHOD FOR THE ABSORPTIOMETRIC DETERMINATION OF FLUORIDE IN URANIUM DICXIDE. (United Kingdom Atomic Energy Authority. Production Group, Springfields, Lancs, England). 1963. 7p.

The oxide is dissolved in phosphoric/sulphuric acid in a distillation flask. Fluoride is steam distilled as hydrofluosilicic acid into a sodium hydroxide solution and determined adsorptiometrically by its bleaching effect on the aluminium solochrome-cyanin complex. The method is suitable for the determination of fluoride in the ranges: 5 to 40 ppm for unsintered material, and 10 to 100 ppm for sintered material. The range may be extended upwards by reducing the aliquot taken after distillation. For unsintered oxide at the 60 ppm level and using the reduced aliquot, the standard deviation was 1.2 ppm. The method is considered to be without bias. (auth)

1507 (PG-Report-501) ANALYTICAL METHOD FOR THE GRAVIMETRIC DETERMINATION OF THORIUM OXIDE IN THORIUM PHOSPHATE. (United Kingdom Atomic Energy Authority. Production Group, Springfields, Lancs, England). 1963. 7p.

The sample is dissolved in nitric acid including if necessary a bisulphate fusion. The thorium is separated by iodate precipitation, followed by hydroxide and oxalate precipitation. The oxalate precipitate is ignited to thorium oxide and weighed as such. The method is considered to be generally free from bias, although an error of −0.2% arising from rejected residue is theoretically possible. The method is suitable for the determination of thorium oxide contents of approximately 60%. At the approximately 60% thorium oxide level, the standard deviation calculated from duplicate determinations on thirty different samples by one or other of three operators is ±0.103 for a single determination. (auth)

1508 (PG-Report-522) ANALYTICAL METHOD FOR THE DETERMINATION OF FLUORIDE IN NATURAL WATERS. (United Kingdom Atomic Energy Authority. Production Group, Springfields, Lancs, England). 1963. 7p.

A volume of the sample is concentrated in the presence of calcium oxide, and the fluoride is separated from the residue by distillation in the presence of nitric and sulfuric acids. The pH of an aliquot of the distillate is adjusted to 3.0 and the fluoride titrated with thorium nitrate solution using chrome azurol S indicator. The method is applicable to fluoride contents of 0.1 to 1.0 μg/ml. The range may be extended by reducing the aliquot of the sample taken. The method is considered to be free from bias. (auth)

1509 (TID-7015(Indexes)) INDEXES TO THE OAK RIDGE NATIONAL LABORATORY MASTER ANALYTICAL MANUAL, 1953–1962. Helen P. Raaen and Ann S. Klein, eds. (Oak Ridge National Lab., Tenn.). Contract W-7405-eng-26. 142p.

This report consists of a key word index, a bibliographic index, an author index, and method-number cross indexes. The key word index was composed from method titles, and the bibliographic index gives the history and current status of each method. The titles entered are those of all unclassified methods included in the Manual from 1953 through 1962. (D.L.C.)

1510 (Y-1447) DETERMINATION OF CHLORIDE IN BERYLLIUM METAL BY X-RAY FLUORESCENCE. J. H. Keyes and J. H. Rowan (Union Carbide Nuclear Co. Y-12 Plant, Oak Ridge, Tenn.). Nov. 21, 1963. Contract W-7405-eng-26. 14p.

X-ray fluorescent analysis was applied to the determination of microgram quantities of chloride in beryllium metal powder. This application is preferable to wet-chemistry applications because of the speed and simplicity of analysis. Evaluation of the method consisted of pipetting a standard chloride solution on beryllium metal powder, drying, pressing into pellets, and analyzing. Analysis of standards

containing from 250 to 2000 μg of chloride per gram of beryllium gave an absolute limit of error (0.95) of ±54 μg. At the mean level of 865 μg, the percent limit of error was ±6.2%. (auth)

1511 A QUANTITATIVE MICRO METHOD FOR DETERMINATION OF SPECIFIC RADIOACTIVITIES OF H^3-PURINES AND H^3-PYRIMIDINES. Edward Koenig and Sven-Olof Brattgard (Univ. of Gothenburg, Sweden). Anal. Biochem., 6: 424-34(Nov. 1963).

A radiometric method is described in which the specific activities of micro quantities of tritiated nucleobases can be determined. The method is based on the measurement of tritium in a gas phase after combustion of the electrophoretically separated bases. After determining the base quantities (1-8 μμmoles) by an adaptation of the microphoretic method of Edström, each base is combusted in a minute capillary bomb by heating in combination with $KClO_4$ and zinc for 3 min. The capillary bomb is transferred to a specially designed counting tube, and its gas contents are released by crushing after the tube is closed. The efficiency of the radiometry is 80% and remains stable for a minimum of 12 hr. The high efficiency, coupled with the low background of 2.5 cpm, enable measurements to be made of very low tritium activities. (auth)

1512 ANALYSIS OF VOLATILE INORGANIC FLUORIDES BY GAS LIQUID CHROMATOGRAPHY. Anthony G. Hamlin, Gordon Iveson, and T. Rowland Phillips (United Kingdom Atomic Energy Authority, Capenhurst, Eng.). Anal. Chem., 35: 2037-44(Dec. 1963).

Specialized equipment and techniques were needed to apply gas liquid chromatography to the analysis of highly reactive, volatile inorganic fluorides. Poly(trifluoromonochloroethylene) oils (Kel-F) were suitable for use as stationary phases after chemical stabilization. Using the equipment developed, in-line analyses of plant streams containing uranium hexafluoride, chlorine trifluoride, chlorine, hydrogen fluoride, and other reactive gases were made. To speed analysis, a split column chromatograph was developed and automated. (auth)

1513 RADIOCHEMICAL DETERMINATION OF CERIUM BY SOLVENT EXTRACTION METHOD. M. A. Awwal (Atomic Energy Center, Lahore, Pakistan). Anal. Chem., 35: 2048-50(Dec. 1963).

An efficient radiochemical method for the determination of cerium(III) was developed based on the principle of the synergic effect in solvent extraction with 2-thenoyltrifluoroacetone and tri-n-butyl phosphate. The mixed solvents enhanced the extraction by 10^3-fold over either of the components alone. The extraction procedure provides a clean and efficient separation of radiocerium from other fission products. The method is particularly suitable for the separation of cerium from solutions of fission product mixtures a year or more out of the reactor. (auth)

1514 SEPARATION OF CALCIUM AND STRONTIUM BY LIQUID ION EXCHANGE. DETERMINATION OF TOTAL RADIO-STRONTIUM IN MILK. F. E. Butler (E. I. du Pont de Nemours & Co., Aiken, S. C.). Anal. Chem., 35: 2069-71(Dec. 1963).

A rapid liquid ion exchange method is described for separating quantities of calcium from strontium in dilute acid solution. Separate extractions were made with di-2-ethylhexyl phosphoric acid (HDEHP) dissolved in toluene after stepwise pH adjustments of the aqueous solution. Calcium, strontium, and other cations in 250 ml of milk were first concentrated in 60 ml of dilute HCl solution by a batch ion exchange resin technique. After separation of calcium and radiostrontium by the liquid ion exchange method, Sr^{89} and Sr^{90} were stripped from the final organic phase with 3N HNO_3 and precipitated from fuming nitric acid. The counting planchet contained only 2% of the calcium and 85 ± 5% of the strontium in the original milk sample. Decontamination factors for Y^{90}, Cs^{137}, K^{40}, La^{140}, and I^{131} were greater than 10^3. Ba^{140}, if present, can be removed by homogeneous precipitation of barium chromate. (auth)

1515 LIQUID-LIQUID EXTRACTION OF CESIUM WITH 2-THENOYLTRIFLUOROACETONE. Peter Crowther and Fletcher L. Moore (Oak Ridge National Lab., Tenn.). Anal. Chem., 35: 2081-5(Dec. 1963).

A new, rapid, highly selective liquid-liquid extraction method for cesium is described. Recent developments for the inhibition of the hydrolysis of 2-thenoyltrifluoroacetone provide the basis for the quantitative extraction of cesium under a variety of conditions. Small amounts of lithium markedly enhance the extraction of cesium with 2-thenoyltrifluoroacetone. Highest extraction coefficients are obtained in the presence of lithium with 2-thenoyltrifluoroacetone dissolved in solvents containing the nitro group; 98% for nitromethane and nitrobenzene. Efficient extraction of other alkali elements is possible under certain conditions. The method is applicable for either tracer or macro quantities of cesium. Several practical applications of the method are proposed. (P.C.H.)

1516 POLAROGRAPHY IN FUSED ALKALI METAPHOSPHATES. Roy D. Caton and Harry Freund (Oregon State Univ., Corvallis). Anal. Chem., 35: 2103-8(Dec. 1963).

Polarograms were obtained with a cell consisting of a platinum microelectrode inserted in a melt contained in a platinum crucible. No reference electrode was employed; the platinum crucible served as a massive and nonpolarizable anode. Electrolyses were carried out in fused $NaPO_3$ at 750°C or $LiPO_3$–$NaPO_3$ at 730°C in which a potential span of 0.95 volt was available between the solvent decomposition processes. Twenty oxides and compounds were studied. U_3O_8, CuO, FeO, Fe_2O_3, and V_2O_5 gave redox waves. Silver was the only species that could be reduced to the metal. The data are interpreted with respect to probable electrode reactions. (auth)

1517 POLAROGRAPHY OF LANTHANUM(III), PRASEODYMIUM(III), AND YTTERBIUM(III) IN ANHYDROUS ETHYLENEDIAMINE. Larry C. Hall and David A. Flanigan (Vanderbilt Univ., Nashville). Anal. Chem., 35: 2108-12(Dec. 1963).

Problems in the polarography of aqueous systems are reviewed. Anhydrous Yb(III), La(III), and Pr(III) acetates in anhydrous ethylenediamine gave a double irreversible wave for Yb (–0.411, –0.747 volt) and single irreversible waves for La and Pr (–0.565, 0.571 volt). A zinc reference and tetrabutylammonium perchlorate electrolyte were used. Coulometry established 1- and 2-electron steps for Yb and 3 electrons for La and Pr. Metal amalgams were shown by chemical tests. Yb(II) gave no anodic waves, since a transfer rate of 1.15×10^{-9} cm sec^{-1} at 0.0 volt caused anodic overvoltages beyond Hg. (auth)

1518 EXTRACTION OF SUBMICROGRAM AMOUNTS OF MOLYBDENUM WITH CUPFERRON-CHLOROFORM USING MOLYBDENUM-99. W. B. Healy and W. J. McCabe (Dept. of Scientific and Industrial Research, Wellington, New Zealand). Anal. Chem., 35: 2117-19(Dec. 1963).

Extraction of Mo at 0.01- to 0.1-μg levels with cupferron-chloroform was followed using Mo^{99}. The extraction is

most efficient, giving a distribution ratio of over 200 between the chloroform and aqueous phases. Over 90% of Mo can be separated in one extraction when only 0.1 μg is present in 1 liter of aqueous phase. Phases must be separated within an hour of extraction, otherwise breakdown of cupferron results in return of Mo to the aqueous phase. Bone samples in preparation for extraction can be ashed at temperatures up to 850°C without loss of Mo. (auth)

1519 SIMULTANEOUS DETERMINATION OF NIOBIUM AND TANTALUM BY NEUTRON ACTIVATION USING NIOBIUM-94m AND TANTALUM-182m AND RAPID RADIOCHEMICAL SEPARATIONS. Chong K. Kim and W. Wayne Meinke (Univ. of Michigan, Ann Arbor). Anal. Chem., 35: 2135-8(Dec. 1963). (TID-19146)

The niobium and tantalum content of rocks, graphite, and stainless steel samples were determined by thermal neutron activation analysis with a 10-minute irradiation of samples in a neutron flux of 10^{12} n cm^{-2} $second^{-1}$. Niobium and tantalum were separated simultaneously, followed by an extraction of niobium-free tantalum with 1-pentanol (n-amyl alcohol). The entire radiochemical separation was completed in less than 10 minutes. The radioactivity and half life of the chemically separated niobium-94m and tantalum-182m were determined by gamma spectrometry. In practice, microgram amounts of niobium and tantalum can be determined simultaneously in 30 minutes by this method. (auth)

1520 EVALUATION OF SOME ANALYTICAL PROCEDURES FOR NIOBIUM-BASE ALLOYS. J. P. McKaveney (Crucible Steel Co. of America, Pittsburgh). Anal. Chem., 35: 2139-44(Dec. 1963).

Analytical data for three commercial niobium-base alloys were used to evaluate conventional chemical and vacuum fusion procedures for carbon, hydrogen, and oxygen. Chemical and optical spectrographic solution procedures developed are discussed regarding the determination of alloying amounts (1 to 25%) of molybdenum, tungsten, titanium, and zirconium. Various chemical, optical, and x-ray spectrographic procedures currently used by industry were compared by round-robin analyses of samples from the three niobium alloys. Examination of the round-robin data enabled conclusions to be drawn concerning the elements that will require additional analytical method development. (auth)

1521 METHOD AND APPARATUS FOR DETERMINATION OF SMALL ISOTOPIC OXYGEN VARIATIONS IN BERYLLIUM OXIDE. R. A. Meyer, S. B. Austerman, and D. G. Swarthout (North American Aviation, Inc., Canoga Park, Calif.). Anal. Chem., 35: 2144-6(Dec. 1963).

An analytical method was developed for detecting small changes in the O^{18} abundance of BeO. The method was tested for 1- to 5-mg samples of finely ground BeO containing 0.2 to 2.0 atom % of the oxygen as O^{18}. A vacuum fusion apparatus using a platinum flux contained in a graphite crucible at 2200°C was used to release the oxygen in BeO as CO. The resultant CO was analyzed for $CO^{18}-CO^{16}$ ratio with a modified mass spectrometer. The standard deviation among 19 successive samples was ±0.002 when the O^{18} abundance was approximately 0.2%. (auth)

1522 ULTRAMICRODETERMINATION OF IODINE BY A RAPID AUTOMATIC REACTION-RATE METHOD. H. V. Malmstadt and T. P. Hadjiioannou (Univ. of Illinois, Urbana). Anal. Chem., 35: 2157-61(Dec. 1963).

An automatic spectrophotometric reaction rate method for the ultramicrodetermination of iodide is based on the Sandell-Kolthoff reaction, in which a trace of iodine or iodide acts as catalyst for the reduction of Ce(IV) in the presence of As(III). The time required for the reaction to consume a small fixed amount of ceric ions, and therefore for the absorbance to decrease by a preselected amount (about 0.06 unit), is measured automatically and related directly to the iodide concentration. Ultramicro amounts of iodide in the range of 0.015 to 0.45 μg were determined with relative errors of about 1 to 2% and measurement times of only about 10 to 100 seconds. The method should be adaptable for the determination of protein-bound iodine (PBI). (auth)

1523 OXYGEN DETERMINATION IN ROCKS, MINERALS, AND WATER BY NEUTRON ACTIVATION. Alexis Volborth and H. E. Banta (Oak Ridge Inst. of Nuclear Studies, Tenn.). Anal. Chem., 35: 2203-5(Dec. 1963).

Oxygen in rocks and minerals is determined using the reaction $O^{16}(n,p)N^{16}$ in a 15-Mev neutron flux of 7×10^8 $n/cm^2/second$, produced by bombardment of a tritiated titanium target by deuteron beam of 500 μa accelerated at 150 kv. The gamma-ray activity of the 7.4-second nitrogen is counted by a NaI(Tl) scintillation crystal and a multichannel analyzer. Two-gram samples are used. The method permits about 80 analyses per day and is nondestructive. The relative standard deviation achieved on a water standard is 0.39%. Using water and ignited oxides TiO_2 and Al_2O_3 as standards, oxygen was determined in rocks G-1 and W-1. Gamma activities used lie in the region of 6 to 7 Mev, whereas most other gamma activities of elements present in the rocks fall in the region of 0 to 3 Mev. The short half life of nitrogen-16 requires exact timing and a fast transfer system. In rocks with F and B the reactions $F^{19}(n,\alpha)N^{16}$ and $B^{11}(n,p)Be^{11}$ have to be taken into account. (auth)

1524 METHODS FOR DETERMINATION OF THE C:H RATIO OF ORGANIC MATERIALS WITH THE HELP OF NULCEAR RADIATION. K. H. Waechter (Frieseke and Hoepfner GmbH, Erlangen-Bruck, Ger.). Atomwirtschaft, 8: 538-41(Oct. 1963). (In German)

The C:H ratio of hydrocarbons may be determined using nuclear radiation by three methods: by the enhanced beta absorption of hydrogen, by the enhanced Compton scattering of hydrogen, and by the slowing down of fast neutrons in hydrogenous materials. Both the first two methods depend on the fact that hydrogen of natural isotopic composition possesses twice as great an electron density as the other elements of low atomic number. All reactions of particle radiation with electrons in which these electrons can be regarded as free are therefore suitable for determining the hydrogen content of the material through which the radiation passes. The highest sensitivity is expected between the particle radiation and the material. This is practically so in the case of beta absorption which can be used to determine the C:H ratio in a satisfactory way. The so-called beta-gamma photometer is discussed as a measuring arrangement for the discontinuous determination of the C:H ratio using beta absorption. In it a constant amount of the substance to be analyzed is weighed out into bulbs having thin entrance and exit windows for radiation so that by irradiating a surface of constant area the radiation always traverses the same surface weight of material. The beta intensity transmitted by the material, which can be measured with a methane flow counter or, for higher accuracy, with an ionization chamber, is a measure of the hydrogen content of the specimen. The immersion, back-scatter and transmission techniques are discussed as typical methods for the measurement of the C:H ratio using neutrons. A comparison of the methods indi-

cated that beta photometry surpasses the others in respect of sensitivity. (auth)

1525 SELF-ABSORPTION CORRECTIONS FOR THE MEASUREMENT OF UNKNOWN BETA ACTIVITIES IN WATER SAMPLES. K. Haberer (Technische Hochschule, Karlsruhe, Ger.). Atomwirtschaft, 8: 541-3(Oct. 1963). (In German)

In monitoring surface water very large errors may arise in the measurement of the total beta activity if K^{40} is used as the calibrating substance. The errors are not particularly serious in the case of uranium fission products, which enter the water through radioactive fallout, and the activities obtained against K^{40} as a standard may be corrected by the use of appropriate factors. The situation is different in the case of radioactive effluent water or surface water contaminated by radioactive effluent. High energy beta emitters, such as P^{32}, and possibly also emitters of very low energy may then both be present. The use of C^{14} and S^{35} is, for instance, very widespread and, because of their low beta energies, the usual total beta activity determination on layers of evaporated deposit of finite thickness can only be made with very low efficiency. If K^{40} is used as a calibrator for these measurements then a far too high efficiency will be assumed and the specific activities so obtained may easily be out by an order of magnitude or more. Corrections could be directly applied on an experimental basis if the nature of the emitter and the energy of its radiation were known, but this is usually not the case. It is suggested, for determination of the self-absorption correction, that the absorption characteristics of the radiation itself be used by measuring the attenuation in an aluminium filter of definite thickness. A study was made to determine whether in such cases a method described by A. H. W. Aten for the correction of self-absorption in the activity measurement of water samples can be applied in practice, particularly if there are several radioisotopes present as a mixture in the water. (auth)

1526 USES OF ISOTOPES IN ADDITION POLYMERIZATION. G. Ayrey (Univ. of London). Chem. Rev., 63: 645-67(Dec. 1963).

A review is presented on advances in the knowledge of addition polymerization of unsaturated monomers that have resulted from the use of isotopes. The use of isotopes as tracers and the mechanistic implications of the kinetic isotope effect are discussed. 217 references are included. (P.C.H.)

1527 THE SPECTROCHEMICAL DETERMINATION OF La, Ce, Pr, Nd, Sm, Gd, AND Dy IN SODIUM RARE EARTH SULPHATES. R. A. Edge (Univ. of Cape Town). Anal. Chim. Acta, 29: 460-5(Nov. 1963).

A d-c arc spectrochemical procedure is described for the analysis of La, Ce, Pr, Nd, Sm, Gd, and Dy in sodium rare earth sulfates derived from monazites. A separate more-sensitive procedure, in which sodium rare earth sulfate was diluted in graphite, was used to determine Dy. The method gives good precision and accuracy. (P.C.H.)

1528 THE DETERMINATION OF SILICA IN ROCKS AND MINERALS BY ISOTOPE DILUTION WITH SILICON-31. R. H. Filby and T. K. Ball (Univ. of Oslo). Analyst, 88: 891-3(Nov. 1963).

An extremely rapid and simple method for determining silica was developed. The method is accurate, reasonably precise, and is not subject to most of the interferences affecting the gravimetric method. Precision is within 2%. (P.C.H.)

1529 A CONVENIENT METHOD FOR THE DETERMINATION OF METABOLICALLY LIBERATED $C^{14}O_2$. Eugene Roberts, Daisy G. Simonsen, and Betty Sisken (City of Hope Medical Center, Duarte, Calif.). Atomlight, No. 33: 9-11(Nov. 1963).

A method is described for the determination of $C^{14}O_2$. The method enables the $C^{14}O_2$ to be trapped in Hyamine base contained in a regulation size counting vial and to be counted under standard conditions without any additional pipetting, thus avoiding the inaccuracies introduced by further transfers. The procedure is suitable for the study of many reactions in which $C^{14}O_2$ is liberated and for virtually all reactions in which an absorbable radioactive gas is liberated. The equipment is also described. (P.C.H.)

1530 SPECTROPHOTOMETRIC DETERMINATION OF MOLYBDENUM IN URANIUM WITH 8-QUINOLINOL. Kenji Motojima, Hiroshi Hashitani, Kimie Izawa, and Hideyo Yoshida (Japan Atomic Energy Research Inst., Tokyo). Bunseki Kagaku, 11: 47-51(Jan. 1962). (In Japanese)

A rapid spectrophotometric method for molybdenum, based on the extraction with chloroform as the 8-quinolinate was developed. Extraction of uranium is prevented by the use of a definite amount of fluoride ion as a masking agent (250 mg of fluoride ion for each 1 gram of uranium). In this condition, optimum pH range for the extraction of molybdenum is from 3.0 to 5.5. Common impurities are tolerated at reasonable levels; all other metals that are apt to accompany with molybdenum can readily be eliminated by washing the extract with an oxalic acid solution (0.1M, pH 1). The method is accurate and rapid for the determination of molybdenum in uranium metal down to 0.5 ppm, and can also be applied to the analysis of uranium oxides or yellow cake containing relatively large amounts of molybdenum. (auth)

1531 DETERMINATION OF TRACE OF CADMIUM IN URANIUM METAL USING METHYL ISOBUTYL KETONE EXTRACTION OF IODINE COMPLEX AND PHOTOMETRIC METHOD WITH DITHIZONE. Daido Ishii and Tsugio Takeuchi (Nagoya Univ., Japan). Bunseki Kagaku, 11: 52-5(Jan. 1962). (In Japanese)

In the determination of a trace amount of cadmium by the photometric method with dithizone, a new method of separation of cadmium was presented, in which its iodo complex was extracted with methyl isobutyl ketone at pH 6 ~ 8. The investigation was made by using Cd^{115m} as a tracer, and the method was applied for the analysis of uranium metal as a nuclear fuel. The sample was dissolved in hydrochloric acid and hydrogen peroxide, followed by the additions of hydroxylamine hydrochloride, potassium iodide, sodium citrate, sodium thiosulfate, and ammonium hydroxide, and the cadmium was extracted with methyl isobutyl ketone. This was taken up in water, followed by the additions of hydroxylamine hydrochloride, sodium citrate, ammonium hydroxide and cadmium-dithizonate was extracted with dithizone-carbon tetrachloride. The cadmium was transferred into dilute hydrochloric acid, the solution was made alkaline and the purified cadmium dithizonate was extracted with dithizone-carbon tetrachloride. Cadmium was determined by measuring the light absorbency at 520 mμ. As little as 0.02 ppm of cadmium in uranium metal was determined by taking 5 g sample. (auth)

1532 DETERMINATION OF ZINC IN METALLIC URANIUM. Yoshio Morimoto, Takashi Ashizawa, and Satoru Takani (Atomic Fuel Corp., Tokyo). Bunseki Kagaku, 11: 56-61(Jan. 1962). (In Japanese)

For determination of zinc in metallic uranium by the dithizone extraction method, the effect of pH on the extraction of zinc-dithizone complex, the concentration of dithi-

zone, and the liberating agent for elution of adsorbed dithizone complex from alumina column were investigated and the following method of determination was established. The sample was dissolved in hydrochloric acid and hydrogen peroxide, it was evaporated to dryness, the residue was treated with ammonium citrate for masking of uranium, aqueous ammonia was added to adjust pH 8.5 ± 0.3, and zinc was extracted as dithizone complex into carbon tetrachloride. The extracted solution was passed through an alumina adsorption column, washed with chloroform for removing of dithizone complexes of nickel and cobalt, the zinc was liberated by use of chloroform-methanol and determined by measuring the light absorbance at 480 mμ. Determination of 0.2 ~ 8 γ of Zn/5ml was made by the proposed method. (auth)

1533 DETERMINATION OF COPPER IN METALLIC URANIUM. Yoshio Morimoto, Takashi Ashizawa, and Kenji Miyahara (Atomic Fuel Corp., Tokyo). Bunseki Kagaku, 11: 61-5(Jan. 1962). (In Japanese)

A rapid method for the determination of copper in metallic uranium using dithizone is proposed. The molecular extinction coefficient of dithizone complexes of various metals and the optimum pH range for the extraction of copper-dithizone complex were investigated. A rapid determination of copper was developed by taking up the sample in hydrochloric acid and hydrogen peroxide, evaporating it to dryness, adjusting the reaction to pH 1.8 ~ 2.2 by addition of aqueous ammonia, extracting copper with dithizone-carbon tetrachloride, and measuring the light absorbance at 531.5 mμ. By this method, estimation of copper in the range of 0.3 ~ 15 μg/5 ml was possible, and the presence of silver up to 10 μg showed no disturbing influence. Subsequent determinations of nickel, cobalt, and zinc from the same sample are also possible. (auth)

1534 PHOTOMETRIC DETERMINATION OF ARSENIC IN URANIUM METAL USING MIBK EXTRACTION AND MOLYBDENUM BLUE. Daido Ishii and Tsugio Takeuchi. Bunseki Kagaku, 11: 118-19(Jan. 1962). (In Japanese)

1535 COLORIMETRIC DETERMINATION OF BERYLLIUM. Hisao Fukamauchi, Ryuko Ideno, Mitsuko Yanagida, and Chiyo Inotsume. Bunseki Kagaku, 11: 121-2(Jan. 1962). (In Japanese)

1536 DETERMINATION OF HYDROGEN AND OXYGEN IN METALLIC URANIUM. Yoshio Morimoto and Akio Hirayama (Atomic Fuel Corp., Tokyo). Bunseki Kagaku, 11: 163-6(Feb. 1962). (In Japanese)

A method is proposed for the determination of hydrogen in metallic uranium in which 0.2 ~ 0.4 ppm of hydrogen was found by extraction in vacuo for 20 min at 900°C instead of using a metal bath. In the determination of oxygen, a metal bath of platinum was found superior to that of iron, and it was indicated that the uranium content must not exceed 10%. The estimation of oxygen was possible by extraction with fusion at 1850°C. Precision of analytical value was much increased by a mere mechanical cleaning of the metal surface. (P.C.H.)

1537 DETERMINATION OF COBALT IN URANIUM METAL. Yoshio Morimoto, Takashi Ashizawa, and Teruko Takenouchi (Atomic Fuel Corp., Tokyo). Bunseki Kagaku, 11: 167-70(Feb. 1962). (In Japanese)

Uranium metal (1 g) was dissolved in hydrochloric acid-hydrogen peroxide, the solution was evaporated to dryness and taken up in 40 ml water. 5 ml of 20% ammonium citrate were added and the pH was adjusted to 8.5 with aqueous ammonia. The whole was transferred into a separatory funnel and metals including cobalt were extracted with 10 ml of 1×10^{-3} M dithizone-carbon tetrachloride solution. The organic layer was washed with 10 ml of 4N hydrochloric acid and passed through an alumina column (0.7 cmϕ × 5 cm) on which the dithizone complexes were chromatographically adsorbed. These were eluted with chloroform. The cobalt complex alone was separated and diluted with 2 ml of chloroform. The absorbancy at 550 mμ was measured using 1 cm cell. Determination of above 0.1 ppm of cobalt was possible with 10% coefficient of variation. (auth)

1538 DETERMINATION OF TRACE OF CHLORINE IN URANIUM METAL BY A. C. POLAROGRAPHY. Daido Ishii and Tsugio Takeuchi (Nagoya Univ., Japan). Bunseki Kagaku, 11: 171-4(Feb. 1962). (In Japanese)

A new analytical method for the determination of a small amount of chlorine in uranium metal was investigated by use of a-c polarography. The sample was dissolved in sulfuric acid and hydrogen peroxide, the excess hydrogen peroxide was decomposed by heating, the sulfuric acid concentration was adjusted to 9N, and an a-c polarogram was obtained by use of dropping mercury electrode. The amount of chlorine was calculated from the wave height ($E_p = -0.15$ v vs Hg) produced by the electrode reaction, $2Hg + 2Cl^- \rightleftharpoons Hg_2Cl_2 + 2e$. The result was not affected by the presence of the other halogens and common elements as impurities in uranium metal. 1 ~ 70 ppm chlorine was determined with good results by taking 1 g sample and making it up to 10 ml of the final solution. (auth)

1539 PHOTOMETRIC DETERMINATION OF TRACES OF SILVER IN URANIUM METAL. Daido Ishii and Tsugio Takeuchi (Nagoya Univ., Japan). Bunseki Kagaku, 11: 174-8(Feb. 1962). (In Japanese)

The sample was dissolved in nitric and sulfuric acids followed by the additions of thallous sulfate and potassium iodide. The silver coprecipitated with thallous iodide was taken up in sulfuric acid and hydrogen peroxide. The solution was evaporated to dryness and the residue was treated with acetic acid (60 vol %) and p-dimethylaminobenzylidenerhodanine (0.004%). The light absorbency at 580 mμ indicated the amount of silver. 0.4 ~ 4 ppm silver in uranium metal could be estimated, provided 5 g sample was taken and was made up into 5 ml of the colored solution. The coprecipitation rate with thallous iodide was confirmed to be more than 95%, by using Ag^{110m} as a tracer. (auth)

1540 SIMULTANEOUS DETERMINATION OF C AND H IN Ta AND Zr. Nakaaki Oda, Masaji Kubo, and Tadahiko Yamagishi (Nippon Soda Co., Ltd., Takaoka, Japan). Bunseki Kagaku, 11: 214-20(Feb. 1962). (In Japanese)

A simultaneous determination of C and H in Ta and Zr was attempted by applying a method previously reported for C and H in Ti and its alloys. In the same apparatus as used in the previous Ti determination, the sample, 5 g of Ta alone or 3 g of Zr with 3 g of Cu as a combustion accelerator was burned at 1300°C in a current of oxygen (180 ml/min), and the percent of C and H is calculated from the amount of CO_2 and H_2O obtained. The coefficient of variation in the determination was 6% for both C and H in Ta or Zr, and the lower limit of determination was 0.005% for each. The time required for an analysis (including both C and H determinations) was 20 min. Conditions for the combustion of C in Ta and Zr in high frequency furnace and for the succeeding determination of CO_2 were also investigated and a method for determining as low as 0.005% of C in Ta and Zr is presented. (P.C.H.)

1541 SPECTROPHOTOMETRIC DETERMINATION OF TRACE IMPURITIES IN REACTOR GRADE BISMUTH.

Masao Takahashi and Yaeko Uruno. Bunseki Kagaku, 11: 247-9(Feb. 1962). (In Japanese)

A method is given for the spectrophotometric determination of trace impurities of B, Cd, Fe, Pb, Sb, and Sn. (P.C.H.)

1542 PHOTOMETRIC DETERMINATION OF TRACE OF ZIRCONIUM IN URANIUM METAL. Daido Ishii and Tsugio Takeuchi (Nagoya Univ., Japan). Bunseki Kagaku, 11: 267-71(Mar. 1962). (In Japanese)

A method for determining small amounts of zirconium in uranium metal was developed, in which zirconium was separated from uranium by stepwise extraction with TBP followed by the coloration of the perchloric acid-treated solution by sodium alizarin-sulfonate. The sample was decomposed with hydrochloric acid, followed by the additions of hydrogen peroxide, perchloric acid, and hydrogen fluoride, and the whole was evaporated to drive off the fluoride. The residue was taken up with 4.5N hydrochloric acid, from which uranium and iron were removed by extraction with TBP-benzene. The aqueous solution was then adjusted to contain 8N hydrochloric acid and zirconium was extracted with the same solvent, from which zirconium was back-extracted into water. The solution was heated with perchloric acid to white fumes, diluted to 0.3 ~ 1N with water, and boiled with sodium alizarin-sulfonate for the color development. The zirconium was determined by the estimation of light absorbancy at 523 mμ. 5 ~ 100 ppm zirconium was determined accurately on 1 g sample made up to 10 ml of the final solution. (auth)

1543 SPECTROPHOTOMETRIC DETERMINATION OF NIOBIUM WITH XYLENOL ORANGE; ANALYSIS OF URANIUM-BASE ALLOYS. Nasumi Ishiwatari and Hiroshi Onishi (Japan Atomic Energy Research Inst., Tokyo). Bunseki Kagaku, 11: 576-81(May 1962). (In Japanese)

A method is described for the spectrophotometric determination of niobium with Xylenol Orange. The sample solution containing 5 ~ 60 μg of niobium is transferred to a 25 ml volumetric flask. Sulfuric acid concentration is adjusted to make the acidity 0.05 ~ 0.25N after diluting to volume. Ascorbic acid is then added to reduce iron(III). Sodium sulfate is added to mask small amounts of thorium. Xylenol Orange is added, followed by aluminum sulfate. The aluminum is added to eliminate the interference of fluoride that is presnet in the sample solution. After diluting to the mark and allowing to stand for 1 hr, the absorbance is measured in a 1 cm cell at 530 mμ, using the reagent blank as the reference. Beer's law is obeyed, and the molar absorptivity is 2.3×10^4. According to the continuous variation and slope ratio methods, the composition of the colored products corresponds to a mixture of NbXO and $Nb(XO)_2$, where XO is Xylenol Orange. The proposed method was applied to uranium-base alloys, and favorable results were obtained. (auth)

1544 RAPID NEPHELOMETRIC DETERMINATION OF CHLORIDE IN URANIUM TETRAFLUORIDE. Kenji Motojima, Hiroshi Hashitani, and Kazuo Katsuyama. Bunseki Kagaku, 11: 582-3(May 1962). (In Japanese)

1545 SPECTROPHOTOMETRIC DETERMINATION OF ZIRCONIUM AND HAFNIUM WITH OXINE AND THE APPLICATION TO THE ANALYSIS OF URANIUM. Kenji Motojima, Hiroshi Hashitani, and Hideyo Yoshida (Japan Atomic Energy Research Inst., Tokyo). Bunseki Kagaku, 11: 659-63(June 1962). (In Japanese)

A fundamental study was made of the spectrophotometric method for the determination of microgram quantities of zirconium and hafnium using oxine. The determination is based on the extraction of their oxinates with chloroform and the spectrophotometric measurement of the extracts. There is not much difference between zirconium and hafnium in the optimum pH range for the extraction (pH 4.5 to 11.3), the wave length of maximum absorption (385 mμ), molar absorbance index (1.4×10^4), and in the effects of several other substances. The method can be used for the determination of 3 to 60 μg of zirconium and 6 to 120 μg of hafnium. The established method was also applied to the separation and determination of zirconium in uranium. Extraction of uranium and aluminum is prevented by the use of acetate and a definite amount of fluoride ion (15 mg of fluoride ion for each 1 gram of uranium), respectively. In this condition, optimum pH range for zirconium extraction is 4.8 to 5.3. The extract is washed with a carbonate-cyanide washing solution to remove copper and nickel. By measuring the absorbances of the extract at 385 and 470 mμ, zirconium and iron can be determined simultaneously. (auth)

1546 DETERMINATION OF BERYLLIUM IN BIOMATERIALS AND NATURAL WATER. Tsunenobu Shigematsu, Masayuki Tabushi, and Fumio Isojima (Kyoto Univ.). Bunseki Kagaku, 11: 752-6(July 1962). (In Japanese)

In order to apply the spectrophotometric acetylacetonate method to the determination of beryllium in sea water, lake water samples and biomaterials, the procedures for the concentration of trace amount of the element, the ashing of the samples, and the removal of the disturbing phosphate were studied. As the decomposition of biomaterials, the dry method was examined, and the ashing at 600°C was found to be the best. Beryllium was not lost on this condition. The coprecipitation with ferric hydroxide was used for the concentration of beryllium. Beryllium was quantitatively recovered when the precipitation was carried at pH 7. Phosphate gave a negative error in the determination of beryllium, and so must be removed. The ferric hydroxide coprecipitation method can be used also for the separation of beryllium from phosphate, and it seemed to be better than the ammonium phosphomolybdate procedure. When ferric hydroxide precipitated at pH 11, in the presence of EDTA, beryllium coprecipitated, while phosphate did not contaminate even when calcium was present as in the biomaterials. The analytical procedures are described. Sea water, lake water samples and several biomaterials such as seaweed were analyzed. (P.C.H.)

1547 ISOTOPE DILUTION METHOD. Takuji Komori. Bunseki Kagaku, 11: 772-9(July 1962). (In Japanese)

The isotope dilution method is compared with other methods for the determination of metals, geological material, ThO_2, and sea water. Methods are given for the determination of C, S, Rb, Sr, U, Th, Nd, Sm, and Eu. (P.C.H.)

1548 FLAME PHOTOMETRIC DETERMINATION OF YTTRIUM. Masao Sato (Tokyo Inst. of Tech.). Bunseki Kagaku, 11: 811-13(Aug. 1962). (In Japanese)

A flame photometric method for the determination of yttrium in yttrium group rare earths is presented. There were three characteristic peaks in flame emission spectrum of yttrium, and two of them (599 mμ, 615 mμ) were used to determine the amount of yttrium in 0.1N hydrochloric acid solution. The relation between log. amount of yttrium and log. intensities of the flame spectra is shown. The amount of yttrium in the impure yttrium solution extracted from xenotime was determined. The effectiveness of the method was recognized by the satisfactory

recovery of yttrium added to the impure yttrium solution. It is recommended for industrial analysis. (auth)

1549 FLUORESCENT X-RAY ANALYSIS OF LANTHANUM, CERIUM, PRASEODYMIUM, AND NEODYMIUM. Yoshihito Takahashi and Eiichi Asada (Government Chemical Industrial Research Inst., Tokyo). Bunseki Kagaku, 11: 926-31(Sept. 1962). (In Japanese)

A method of fluorescent analysis by the use of characteristic x ray of K series was developed for the determination of lanthanum, cerium, praseodymium, and neodymium. The spectrochemical analysis of the elements is simplified by utilizing K spectra, since these can be separated much more readily than L spectra. Furthermore, the pulse height analyzer employed in conjunction with an analytical crystal gives a successful result in separating the K spectra from K and L spectra of other coexisting elements such as yttrium and thorium. The intensities of K spectra of the rare earth elements are almost independent on the presence and chemical state of light elements such as silicon and phosphorus. The calibration curve for the analytical use is quite the same on each rare earth element within experimental error, as far as the intensity for 30% content is taken as unity. The analytical error of the method is ±1.5% for 20% content and ±3.0% for 60% content, provided that the content of yttrium and thorium does not exceed 1.5 and 0.2%, respectively. (P.C.H.)

1550 VOLUMETRIC DETERMINATION OF TIN IN ZIRCONIUM ALLOYS AND THEIR MATERIALS. Masao Kawahata, Heiichi Mochizuki, Rokuro Kajiyama, and Masao Ishii (Nippon Yakin Kogyo Co., Ltd., Kawasaki, Japan). Bunseki Kagaku, 11: 963-6(Sept. 1962). (In Japanese)

A volumetric method is described for the determination of tin in zirconium alloys and their materials. The procedure is based on the direct reduction of tin to the bivalent state with metallic aluminum and iron turnings in the presence of titanous ions and the subsequent oxidation of tin with a standard potassium iodate solution in an atmosphere of carbon dioxide. A sample was decomposed by hydrofluoric–nitric acid mixture, followed by an addition of sulfuric acid and evaporation to fumes of sulfur trioxide. The solution prepared in this way was adjusted to (1 + 1) with respect to hydrochloric acid concentration, transferred to a reduction unit and then treated as described, where titanous ions were added to the solution to avoid the interference of dissolved oxygen in the potassium iodate solution. The method was suitable for the determination of 0.1 to 20% tin in zirconium alloys and their materials, and was superior in its simplicity and rapidity. No significant error was introduced by the presence of zirconium, titanium, aluminum, manganese, and nickel, but a large amount of chromium gave an erratic value. (auth)

1551 SPECTROPHOTOMETRIC DETERMINATION OF URANIUM IN ORES WITH 8-QUINOLINOL. Kenji Motojima, Hiroyuki Yoshida, and Tsuyoshi Imahashi (Japan Atomic Energy Research Inst., Tokyo). Bunseki Kagaku, 11: 1028-32(Oct. 1962). (In Japanese)

A method for the sensitive and rapid spectrophotometric determination of uranium in ores using 8-quinolinol was developed. Uranium is separated by extraction with tributylphosphate-kerosene from nitric acid solution. After the back-extraction of uranium with ammonium carbonate solution, uranium is determined spectrophotometrically with 8-quinolinol. When 1 gram of sample is taken, as little as 0.005% of uranium can be determined precisely. Uranium in monazite is also determined by this method. (auth)

1552 DETERMINATION OF HAFNIUM IN ZIRCONIUM BY MEANS OF SOLVENT EXTRACTION WITH CYCLOHEXANONE. Yoshio Hoshino (Tokyo Inst. of Tech.). Bunseki Kagaku, 11: 1032-40(Oct. 1962). (In Japanese)

The separation method using cyclohexanone was successfully applied to the determination of small or trace amount of hafnium in zirconium. When an aqueous solution of zirconium sample containing ammonium thiocyanate, ammonium sulfate, and hydrochloric acid was contacted with cyclohexanone by shaking, hafnium in zirconium was preferentially extracted into cyclohexanone. The organic phase was back-washed repeatedly with aqueous solution containing ammonium thiocyanate, ammonium sulfate, and hydrochloric acid and finally hafnium in the organic phase was perfectly purified. Then, hafnium back-extracted into 4N sulfuric acid solution was either titrated with EDTA or estimated by the spectrophotometry with morin. On the other hand, the yield of hafnium in the organic phase was measured either radiochemically with a tracer of hafnium-181 which was added previously into the sample or by the analysis of the extraction curves. From these results, the content of hafnium in the zirconium sample was calculated. The method is superior to other methods in respect to easiness of procedure and higher sensibility in case of determination of hafnium in the so-called nuclear reactor grade zirconium. (P.C.H.)

1553 RELATION BETWEEN THE CHEMICAL STRUCTURE OF SOLVENT MOLECULES AND THEIR EXTRACTABILITY FOR HAFNIUM AND ZIRCONIUM. Yoshio Hoshino (Tokyo Inst. of Tech.). Bunseki Kagaku, 11: 1040-50 (Oct. 1962). (In Japanese)

The distribution ratios of hafnium and zirconium thiocyanates between organic solvents and hydrochloric acid were tabulated for 80 kinds of solvent containing oxygen in their structure including ketones, alcohols, ethers, and esters. The measurements were carried out with the aid of radioactive tracers, and the relation between the chemical structure of solvent molecule and the distribution ratio, as well as the separation factor, was extensively surveyed. Among the solvents with similar structures, the distribution ratio was lowered with an increase in the number of carbon atoms, in the branching of the side chain, and in the symmetric molecule structure against the functional groups, although solvents with smaller number of carbons, did not follow the first tendency. Among the solvents with different structures, the distribution ratio was lowered in the order as alicyclic ketones > aliphatic ketones > esters > alcohols > ethers. The separation factor became greater with an increase of distribution ratio for hafnium. (auth)

1554 SEPARATION AND DETERMINATION OF TRACE AMOUNTS OF CADMIUM IN THORIUM COMPOUNDS. Shizo Hirano, Atsushi Mizuike, and Yoshio Iida (Tokyo Univ). Bunseki Kagaku, 11: 1127-31(Nov. 1962). (In Japanese)

An ion exchange separation was applied to the polarographic determination of trace amounts of cadmium in reactor-grade high-purity thorium compounds. A hydrochloric acid solution of the sample is introduced into an anion exchanger column (Amberlite IRA-400, Cl-form, 50 to 100 mesh, 1.8 cm $\phi \times 4$ cm). Cadmium, as its negatively charged chloride complex, is retained strongly in the column, whereas thorium passes through completely. The cadmium is then desorbed with 1N nitric acid, and determined finally by means of a d-c or a-c polarograph. A hundredth to 5 ppm of cadmium in thorium can be determined by the method with an accuracy of about 10% at 0.1 ppm. The time required for a determination is approxi-

mately 3 to 4 hr. A modified procedure is also proposed by the use of liquid ion exchanger (Amberlite LA-2, as 10% xylene solution) instead of the ion exchange resin. This procedure saves time without a serious loss of accuracy comparing with the original one. (auth)

1555 THE ANALYTICAL METHODS FOR CALCIUM-SILICON CONTAINING A LARGE AMOUNT OF RARE EARTHS. Masao Kawahata, Heiichi Mochizuki, Rokuro Kajiyama, and Masao Ishii (Nippon Yakin Kogyo Co., Ltd., Kawasaki, Japan). Bunseki Kagaku, 11: 1132-6(Nov. 1962). (In Japanese)

A method is presented for the determination of total rare earths, cerium, silicon, iron, and calcium in calcium-silicon containing a large amount of rare earths. Total rare earths together with iron were separated from calcium by precipitation with ammonium hydroxide. The precipitate was dissolved in hydrochloric acid, adjusted to pH 2, oxalic acid was added for precipitation of total rare earths, and they were weighed after ignition. Cerium in the precipitate was dissolved in sulfuric acid, the solution was oxidized with ammonium persulfate in the presence of silver nitrate and titrated with ferrous ammonium sulfate and potassium permanganate. Calcium, iron, and silicon were determined by the conventional methods. Fundamental experiments were carried out in detail, and good results were obtained for the analysis of a sample containing 0.05% carbon, 15% calcium, 25% rare earth metals, and 5% iron, respectively. (auth)

1556 EDTA TITRATIONS OF ZIRCONIUM AND HAFNIUM AND THEIR PRACTICAL APPLICATIONS. Yōhē Tsuchiya (Nagoya Municipal Industrial Research Inst., Japan). Bunseki Kagaku, 11: 1176-80(Nov. 1962). (In Japanese)

EDTA titrations of zirconium and hafnium can be performed in boiling solutions containing 0.9 ± 0.3N free hydrochloric acid using xylenol orange as an indicator. The color change is from red to yellow, which should persist on boiling for one minute. Interferences are not caused by 1 g of uranium(VI), iron(II), aluminum, zinc, tin, or magnesium, 0.1 g of titanium or sulfate, and 1 mg of phosphate ions. Iron(III) must be reduced with tin(II) chloride. Interference from 0.1 g of thorium can be overcome by addition of about 5 mg of sulfate ion. When hafnium is present with zirconium, the former can be calculated by combining the gravimetric method with mandelic acid. The method was successfully applied for the rapid determination of zirconium and hafnium in zircon sands, special porcelains, and a magnesium alloy. (auth)

1557 DETERMINATION OF URANIUM(VI) IN URANIUM DIOXIDE BY A. C. POLAROGRAPHY. Tsugio Takeuchi and Masami Suzuki. Bunseki Kagaku, 11: 1192-4(Nov. 1962). (In Japanese)

1558 INDIRECT DETERMINATION OF RARE EARTHS WITH VANADIC ACID AND HEXAMETHYLENETETRAMINE. Shigeo Hara (Government Industrial Research Inst., Osaka). Bunseki Kagaku, 12: 1-4(Jan. 1963). (In Japanese)

It was found that rare earth elements formed a precipitate stoichiometrically combining with vanadic acid and hexamethylenetetramine, and an indirect determination of rare earths was made by the estimation of vanadium in the precipitate. The composition of the precipitate was considered to be $M(VO_3)_3 \cdot 8HVO_3 \cdot 2Hexa \cdot 4H_2O$, where M = rare earth elements and Hexa = hexamethylenetetramine. The pH for complete precipitation was 3 to 5 for Pr, La, and Nd, and 4 to 5 for Sm whereas the precipitation of Ce was incomplete. The recommended method is as follows. The solution containing rare earth elements is adjusted to pH 4.5 with acetic acid-ammonium acetate and ammonium vanadate about 20 moles equivalent against the rare earths is added. After an addition of 10 ml of 2% hexamethylenetetramine with stirring, the precipitate was separated and washed with a solution of pH 4.5 containing hexamethylenetetramine. It is dissolved in sulfuric acid and the solution is titrated with standard ferrous sulfate using diphenylamine as an indicator. Above 1 mg of rare earth element was successfully determined. (auth)

1559 QUANTITATIVE DETERMINATION OF PARA-, ORTHO-HYDROGEN, HYDROGEN DEUTERIDE AND DEUTERIUM BY GAS CHROMATOGRAPHY. Katsuyoshi Fujita and Takao Kwan (Tokyo Univ.). Bunseki Kagaku, 12: 15-20 (Jan. 1963). (In Japanese)

Two methods for the gas chromatographic determination of hydrogen nuclear spin isomers and isotopes were investigated with special reference to their accuracy and practicability. One is based on utilizing two sorts of column packings connected in series; the first contains alumina and the second alumina coated with manganese chloride. The chromatogram may yield four peaks corresponding to p-H_2, o-H_2, HD, and D_2. The other needs two acts for the analysis. A portion of hydrogen sample is introduced on alumina column that gives rise to three peaks corresponding to p-H_2, o-H_2 plus HD, and D_2, respectively. The remaining portion is introduced on alumina-manganese chloride column by which three peaks corresponding to H_2, HD, and D_2 may be obtained. From these the composition of four hydrogen molecular species may readily be determined. The two methods were applied to the quantitative analysis of hydrogen isomers and isotopes of known composition. All peaks appeared within 5 to 15 min, the composition agreeing with the expected value within ±2% accuracy. (P.C.H.)

1560 DETERMINATION OF TRACE AMOUNTS OF SILVER IN THORIUM COMPOUNDS BY THE USE OF THE EXTRACTION WITH DITHIZONE. Shizo Hirano, Atsushi Mizuike, Yoshio Iida, and Yoichi Hasegawa. Bunseki Kagaku, 12: 61-3(Jan. 1963). (In Japanese)

1561 SEPARATION AND DETERMINATION OF TRACE AMOUNTS OF SILVER IN THORIUM COMPOUNDS BY THE USE OF CARRIER PRECIPITATION WITH p-DIMETHYLAMINOBENZYLIDENERHODANINE AND PHOTOMETRIC MERCUPRAL METHOD. Shizo Hirano, Atsushi Mizuike, and Yūsuke Ujihira (Tokyo Univ.). Bunseki Kagaku, 12: 160-3(Feb. 1963). (In Japanese)

A method is described for the determination of microgram quantities of silver in thorium oxide or nitrate. An ethanolic p-dimethylaminobenzylidenerhodanine solution is added to an aqueous solution of thorium nitrate of the pH 1 to 2, and after 3 hours, the resulting precipitate is filtered off. Silver is carried down with the precipitate, whereas thorium remains in the solution. The precipitate is dissolved in nitric acid, and the solution is evaporated to near dryness with perchloric and sulfuric acids to decompose organic matter. The residue is then dissolved in dilute sulfuric acid, and the solution is shaken with a mercupral-benzene solution. Silver is determined by color decrease of the organic phase at 440 mμ. Experiments using Ag^{110m} and synthetic sample solutions indicate that 0.2 to 1.0 ppm of silver in thorium oxide can be determined by the proposed method within an error of ±0.1 ppm. (auth)

1562 SPECTROPHOTOMETRIC METHOD FOR THE DETERMINATION OF SCANDIUM WITH PONTACHROME

AZURE BLUE B. Tsunenobu Shigematsu, Katsuya Uesugi, and Masayuki Tabushi (Kyoto Univ.). Bunseki Kagaku, 12: 267-70(Mar. 1963). (In Japanese)

A new method for the spectrophotometric determination of scandium was studied, using Pontachrome Azure Blue B (Color index 43830) as a reagent. Scandium reacts with the reagent at pH 6 ~ 7 to form a complex, of which composition seems to be ScR_2. The complex shows an absorption band with a maximum at 610 mμ, which can be used for the determination of scandium. Beer's law is obeyed in the concentration from 0.03 to 1 ppm of scandium, and the molar extinction coefficient is 31,500 1/M cm at 610 mμ. The reagent reacts also with rare earths, although the absorption of their complex is not so large. Along with large amounts of rare earths, Y, Bi, Fe(III), Cu, Al, W, Ti, Cr, and Be interfere with the determination of scandium. (auth)

1563 POLAROGRAPHIC DETERMINATION OF URANIUM IN TBP-KEROSENE IN THE REPROCESSING OF NUCLEAR FUEL. Kenji Motojima and Kazuo Katsuyama (Japan Atomic Energy Research Inst., Tokyo). Bunseki Kagaku, 12: 358-63(Apr. 1963). (In Japanese)

In the reprocessing of irradiated uranium (Purex process) it is necessary to determine uranium extracted in TBP-kerosene, and a polarographic method is proposed for this purpose. Less than 1 g of the sample, TBP-kerosene solution, is weighed into a electrolytic cell, and 10.0 ml of the supporting electrolyte (mixture of 100 ml of 2N sulfuric acid, 90 ml of ethyl alcohol and 10 ml of 0.4% Tween-80 ethyl alcohol solution) is added. The solution is mixed and deaerated by passing nitrogen for about 10 minutes, and then it is subjected to polarography (−0.6 ~ −1.2 v vs Hg). The proposed method is simple and suitable for remote handling. Ten to 80 mg of uranium in up to 1 g of TBP-kerosene can be determined without the effects of radiation damage. (auth)

1564 SPECTROPHOTOMETRIC DETERMINATION OF SCANDIUM USING ERIOCHROME CYANINE R. Taitiro Fujinaga, Toru Kuwamoto, and Kazuo Kuwabara. Bunseki Kagaku, 12: 399-400(Apr. 1963). (In Japanese)

1565 PAPER PRECIPITATION CHROMATOGRAPHY OF INORGANIC IONS WITH CUPFERRON SEPARATION AND DETECTION OF Fe^{3+}, Cu^{2+}, Hg^{2+}, Zn^{2+}, AND UO_2^{2+}. Hideo Nagai (Kumamoto Univ., Japan) and Tosio Deguchi. Bunseki Kagaku, 12: 552-5(June 1963). (In Japanese)

A modification of paper chromatography is presented in which Fe^{3+}, Cu^{2+}, Zn^{2+}, Hg^{2+}, and UO_2^{2+} were separated into their concentric precipitate zones of their cupferron complex on a filter paper disk. Sheets of Toyo filter paper No. 5B φ 9 cm were treated with 1% alcoholic solution of cupferron, dried for about 24 hours, and preserved in an air-tight vessel filled with ammonia vapor. A drop of sample solution was spotted on center of the disk and it was developed immediately. The best result was obtained by the development with 3 to 16% acetic acid or 5 to 10% n-butyric acid, with complete separations of Fe^{3+}, Cu^{2+}, Hg^{2+}, Zn^{2+}, and of Fe^{3+}, Cu^{2+}, Zn^{2+}, and UO_2^{2+}. (auth)

1566 ANALYSIS OF ZIRCONIUM AND HAFNIUM. PART I. Takuji Ito and Yoshio Hoshino. Bunseki Kagaku, 12: 587-95(June 1963). (In Japanese)

A review is presented on the analysis of Hf and Zr. 110 references are included. (P.C.H.)

1567 ANALYSIS OF ZIRCONIUM AND HAFNIUM. PART II. Takuji Ito and Yoshio Hoshino. Bunseki Kagaku, 12: 695-702(July 1963). (In Japanese)

A review is presented on the determination of Hf and Zr. 201 references are included.

1568 DETERMINATION OF ISOTOPIC RATIOS OF URANIUM BY A THERMOIONIZING METHOD. Yoshihiro Mori, Tadao Kanzaki, and Hidetake Kakihana (Tokyo Inst. of Tech.). Bunseki Kagaku, 12: 736-41(Aug. 1963). (In Japanese)

A thermoionizing method was applied to the determination of isotopic ratios of uranium. It was confirmed that the double-collector method (compensation method) is more accurate and more practical than the single-collector method. The accuracy of the former is ±0.2%, while that of the latter is ±0.6%. Both uranyl nitrate $\{UO_2(NO_3)_2\}$ and uranyl chloride (UO_2Cl_2) can be used as uranium sample for the determination, although it is desirable to use the same salt in a series of experiments. The current of ionization filament and vaporization filament must be held constant in a series of experiments. The same ionization case must be used to compare the isotopic ratios of uranium. The time required for a measurement is about 60 ~ 90 minutes. (auth)

1569 COLORIMETRIC DETERMINATION OF ZIRCONIUM. Hisao Fukamauchi, Ryuko Ideno, Chiyo Matsubara, and Michiko Kagawa. Bunseki Kagaku, 12: 745-7(Aug. 1963). (In Japanese)

1570 GRAVIMETRIC DETERMINATION OF ZIRCONIUM (AND THORIUM) USING N-PHENYLGLYCINE, SUCCINIC ACID, AND ADIPIC ACID. B. D. Jain and S. P. Singhal (Univ. of Delhi). Current Sci., (India), 32: 66-7 (Feb. 1963).

Succinic and adipic acids are reported to completely precipitate Th; it has now been found that N-phenylglycine completely precipitates Zr and Th in the pH range 2.0–3.8 and 3.8–4.0, respectively. Malonic acid precipitates Zr incompletely, while succinic and adipic acids bring about its complete precipitation in the pH range 3.0–3.5 and 2.0–3.5, respectively. N-phenylglycine, which was prepared from chloracetic acid and aniline, in 0.5–1 g amounts was added to 100-150 ml of a solution containing ~10 mg of ThO_2 or ZrO_2 and the pH of the solution adjusted with the addition of hydrochloric acid or ammonia. The solution was boiled for 1-2 min, cooled to room temperature, and then filtered through Whatman filter paper No. 40. The precipitate was washed with a 1% aqueous solution of N-phenylglycine (adjusted to the same pH as the experimental solution), dried, and ignited to give the oxide. ZrO_2 and ThO_2 were then determined gravimetrically, and the results compared with those obtained using the oxine method. Also presented is a technique for the gravimetric determination of Zr using malonic, succinic and adipic acids. The procedure is similar to that described above. (BBB)

1571 SOME CONSIDERATIONS ON THE "COPPER SPARK" METHOD. EFFECTS OF THE EXCITATION. Z. Hainski (CCR Euratom, Ispra, Italy); G. Rossi, and R. Trucco. Energia Nucl. (Milan), 10: 488-92(Sept. 1963). (In Italian)

The "copper spark" method is a very sensitive analytic means in the domain of emission spectrography using high-voltage spark excitation. A study is made to determine to what extent the characteristics of the spark-producing circuit are able to influence the sensitivity and reproducibility of the method. Two different excitation sources are used for the same quantitative determination. The two sources differ in that one uses a guided discharge in a complex apparatus, while the second uses an unguided discharge in a rudimentary apparatus. No difference is found between the efficiencies of these two sources. (tr-auth)

1572 TRACE DETERMINATION OF URANIUM IN MINERALS CONTAINING IRON, TITANIUM AND ZIRCONIUM. F. Gazzarrini (Laboratori di Geologia Nucleare, Pisa, Italy). Energia Nucl. (Milan), 10: 493-5(Sept. 1963).

A polarographic method for the determination of U in the presence of Fe, Zr, and Ti is proposed. The application of this method to the determination of traces of uranium in magnetite, ilmenite, and zircon is described. Results are reproducible within ±3% and were found to be in good agreement with data obtainable from spectrophotometric analysis. (auth)

1573 THE SPECTROPHOTOMETRIC DETERMINATION OF IRON AND ALUMINUM IN URANIUM. E. N. Pollock (Nuclear Metals Inc., Concord, Mass.). Energia Nucl. (Milan), 10: 496-8(Sept. 1963).

Rapid methods for the determination of iron and aluminum in trace and alloying levels in uranium are described. Uranium samples are dissolved in HCl and HNO_3. Iron is determined spectrophotometrically as the ferrous bathophenanthroline complex in an acetone-aqueous solution. Aluminum is determined spectrophotometrically after the chloroform extraction of its 8-hydroxyquinolate complex from a solution containing ammonium carbonate, mercaptoacetic acid, and potassium cyanide as complexing agents for the uranium and minor constituents in the samples. A comparison of data on the analysis of iron by bathophenanthroline and orthophenanthroline procedures is presented. Data indicating the accuracy and precision of the methods are also presented. (auth)

1574 LOW-LEVEL RADIUM CONTENT IN WATER DETERMINED BY ALPHA COUNTING. H. Duquesne, E. E. Godfroi, J. Govaerts, R. Warin, and J. Michiels (Université, Liège). Health Phys., 9: 927-30(Sept. 1963).

A new method is described for radioanalysis by α counting of the Ra content of natural and drinking water. A series of different specific chemical separations permits the isolation of Ra from those impurities usually carried down by the $BaSO_4-RaSO_4$ complex. The precipitate finally obtained is thoroughly mixed with ZnS(Ag). A photomultiplier tube is used for the counting. The method is independent of the number of SO_4^{--} ions present. It is possible to operate with thin layer samples in order to obtain a better efficiency. A particular electronic device which required special attention is described. For routine work, efficiency of 52% was obtained. The background can be reduced to 0.4 counts/min, and concentrations of Ra as low as 10^{-16} to 10^{-17} C/ml can be detected. A critical study of the decay and of the increase of the α activity indicates the relative abundance of Ra^{226}, Ra^{223}, and Ra^{224}. (auth)

1575 DETERMINATION OF CONCENTRATIONS OF AIRBORNE RADIOACTIVITY. George Lewis Helgeson (General Electric Co., San Jose, Calif.). Health Phys., 9: 931-42(Sept. 1963).

Airborne radioactivity may be measured by three main methods: sampling techniques followed by suitable monitoring, sampling techniques concurrent with suitable monitoring, or by directly measuring the radioactivity from a known volume of air. The interpretation of air sampling and monitoring data obtained from the first two techniques, including the effect of half life on sample radioactivity is discussed. Subjects covered are: derivation of air sampling equations; evaluation of data from fixed collecting medium continuous air monitors; evaluation of data from moving collecting medium continuous air monitors, with immediate counting or with post collection counting; evaluation of data for the above air monitoring instruments when the half life is short compared to the sampling interval of concern, the half life is long compared to the sampling interval of concern, and the half life is similar to the sampling interval of concern. The effect of changes in concentration as a function of time is also discussed. Examples are given for each condition. (auth)

1576 ANALYSIS OF URANIUM(IV) OXALATE. D. S. Bharadwaj and A. R. Vasudeva Murthy (Indian Inst. of Science, Bangalore). Indian J. Chem., 1: 493-4(Nov. 1963).

An accurate method for the estimation of uranium and oxalate contents in uranium(IV) oxalate was standardized by separating the components before their determination. Oxalate content is estimated by permanganate titration while uranium is determined by gravimetric method. (OTS)

1577 LIQUID SCINTILLATION COUNTING OF I^{131} IN A CLINICAL LABORATORY. H. Horwitz, J. G. Kereiakes, E. L. Saenger, and Theodore Selkirk (Univ. of Cincinnati). J. Nucl. Med., 4: 426-38(Nov. 1963).

A standard method was developed for the liquid scintillation counting of I^{131} β particles in plasma volumes from 1 to 3 ml with a counting efficiency of 52.5 to 48%. No chemical preparation of the sample is required. For the purposes of estimating total serum I^{131}, protein bound I^{131}, and RISA, this method is practical and simple. Its sensitivity permits reductions of the tracer dose of I^{131} by 2 to 5 orders of magnitude. Liquid scintillation counting is also a value in chromatographic analysis and quantitation of iodinated compounds in the peripheral blood and in urine. The smallest detectable activity using this technique is approximately 1.3 $\mu\mu$C/ml of plasma using a 30 min counting time. Measurements of I^{131} conversion ratios in plasma using a tracer dose of 10 μC to the patient are reported, where previously 50 μC was used for the conventional γ-counting procedure. Experiments to develop similar techniques and to determine maximum merit values for counting I^{131} in whole blood are in progress. (auth)

1578 THE DETERMINATION OF TRACE QUANTITIES OF COPPER IN BIOLOGICAL MATERIAL BY RADIOACTIVATION ANALYSIS. J. Pijck, J. Ruttink, and A. Claeys (Univ. of Ghent). J. Pharm. Belg., 16: 207-16 (May-June 1961).

Aliquots of pure Cu standards were irradiated simultaneously under identical conditions with samples of unknown Cu content. After irradiation the Cu was separated selectively and quantitatively from the biological samples, and its radioactivity compared with the activity of the standards. Corrections were made for dilution and for radioactive decay. Interference due to fast neutrons was investigated since they might give rise to Cu formation by the reaction $Zn^{64}(n,p)Cu^{64}$ from the Zn in biological specimens. The extent of this possible interference was determined under the actual irradiation conditions used for activation analyses. Zn specimens containing 2×10^{-3}% of Cu were separately irradiated in the central flux and in the thermal column of the BR-1 reactor. Irradiation in the thermal column exclusively gave rise to the $Cu^{63}(n,\gamma)Cu^{64}$ reaction whereas centrally irradiated specimens had a higher specific Cu activity due to the simultaneous reactions: $Cu^{63}(n,\gamma)Cu^{64}$ and $Zn^{64}(n,p)Cu^{64}$. For the Zn/Cu ratio of 5×10^4 present in the samples, the interference was about 1%. However, the Zn/Cu ratio in biological material lies at least a factor of 100 lower, so these errors become negligible. Biological specimens and Cu standards sealed in polyethylene containers were irradiated for 24 hr in a central flux of 5×10^{11} to 8×10^{11} n cm^{-2} sec^{-1}. Counting was performed with a Tl-activated NaI-scintillation well-

type crystal, combined with a Super-scaler SC 18. Calculations of the Cu concentration were based on comparison with the activity of standard samples irradiated under identical conditions. Compared with the spectrophotometric method, the results obtained by radioactivation analysis are on the average 3% too high, but reproducibility is good. The advantage of the radiometric method is in the considerable reduction of the sample size (from 10 ml for the spectrophotometric method down to 25 μl). It should be possible to determine Cu down to the 0.1-0.05-μg range. (BBB)

1579 DETERMINATION OF MICRO AMOUNTS OF URANIUM USING 1-(O-ARSONOPHENYLAZO)-2-NAPHTHOL-3,6-DISULFONATE (THORON) AS A COLORIMETRIC REAGENT. Satendra P. Sangal (Univ. of Allahabad, India). Microchem. J., 7: 331-5(Sept. 1963).

The formation of 1:1 red color chelate (λ_{max} 510 mμ) between uranyl ion and 1-(o-arsonophenylazo)-2-naphthol-3,6-disulfonate (thoron) was used for the colorimetric determination of uranium. Measurements are possible over a wide range of temperature (up to 100°C) between pH 2.5 and 5.0. The system obeys Beer's law from 0.63 to 34.2 ppm of uranium. The sensitivity is 0.096 v/cm^2 (Sandell) and 0.96 v/cm^2 (practical). The presence of several cations and anions interfere in the determinations. (auth)

1580 CHROMATOGRAPHIC SEPARATION AND DETERMINATION OF NIOBIUM, TANTALUM AND TITANIUM. I. Martin and R. J. Magee (Queen's Univ., Belfast). Talanta, 10: 1119-23(Nov. 1963).

Following a critical study of the composition of solvent mixtures that separate niobium, tantalum, and titanium by partition chromatography, a solvent mixture was developed that gives ideal R_f values for the elements. Its composition is 2.2M hydrofluoric acid-2M nitric acid-diethyl ketone. Separation is complete in about 30 min. The method was applied to the determination of these elements. (auth)

1581 THE DETERMINATION OF TRACES OF IRON IN SAMPLES OF PLATINUM BY NEUTRON-ACTIVATION ANALYSIS. D. F. C. Morris and R. A. Killick (Brunel Coll., London). Talanta, 10: 1153-7(Nov. 1963).

A neutron-activation analysis method for the determination of traces of iron in samples of purified platinum is described. The nuclear reactor BEPO at Harwell was used as the neutron source. A rapid radiochemical separation procedure using carriers was employed to decontaminate the iron activity from most other induced activities. The analysis is completed by discriminated γ scintillation counting. Results of analyses of seven samples of platinum are quoted. The method of analysis has the advantage that it obviates difficulties caused by reagent blanks or by contamination from traces of inactive iron after irradiation. Interference resulting from nuclear reactions of elements other than iron in the samples appears to be of no consequence. (auth)

1582 SPECTROPHOTOMETRIC STUDIES OF LOWER OXIDATION STATES OF TECHNETIUM. G. B. S. Salaria, Charles L. Rulfs, and Philip J. Elving (Univ. of Michigan, Ann Arbor). Talanta, 10: 1159-63(Nov. 1963).

The spectrophotometric behavior of lower oxidation states of technetium, obtained by reducing pertechnetate under different conditions by various methods, was examined. Contrary to some previously advanced conclusions regarding the ascorbic acid reduction of pertechnetate, it was found that the technetium is reduced to a quadrivalent state. The latter product does not appear to involve a tightly-bound ascorbate species; neither does it significantly react or complex with α-picolinic acid to give a new species. (auth)

1583 COMPLEXOMETRIC TITRATION OF YTTRIUM AND THE LANTHANONS. I. A COMPARISON OF DIRECT METHODS. S. J. Lyle and Md. M. Rahman (Univ. of Durham City, Eng.). Talanta, 10: 1177-82(Nov. 1963).

A comparison was made of a number of direct complexometric titrations previously published for the determination of yttrium and the lanthanons. Working and optimum pH ranges were obtained for what are considered to be the best indicators, Alizarin Red S screened with Methylene Blue, Eriochrome Black T, Copper-Naphthyl Azoxine, and Xylenol Orange. The precision and accuracy of the selected methods were determined by carrying out replicate titrations on standard solutions of cerium(III), yttrium, and ytterbium. The results, together with additional observations made on the behavior of indicators in the different methods, suggest that Xylenol Orange at pH 5.8 to 6.4 is most satisfactory and convenient for direct titrations. (auth)

1584 COMPLEXOMETRIC TITRATION OF YTTRIUM AND THE LANTHANONS. II. METHODS FOR THEIR DETERMINATION IN OXALATES. S. J. Lyle and Md. M. Rahman (Univ. of Durham, Durham City, Eng.). Talanta, 10: 1183-7(Nov. 1963).

Complexometric methods for the determination of yttrium and the lanthanons in oxalate precipitates were investigated. In the method recommended, excess EDTA is added to a suspension of the oxalate, and solution is effected at pH 10 with ammonia–ammonium chloride buffer. The excess EDTA is titrated with standard zinc solution to the blue to red color change of Eriochrome Black T indicator. It is more convenient, and generally more satisfactory, than the method previously suggested, in which magnesium is the back-titrant at pH 10.2 to 10.5. Both of the methods are superior to the back-titration with lanthanum using Arsenazo as indicator at pH 8 to 9 in the presence of oxalate, and more convenient than methods in which the oxalate is removed by wet oxidation before titrating directly with EDTA. The zinc titration method is particularly suitable for chemical-yield measurement in radiometric determinations of yttrium and lanthanons precipitated as oxalates for counting purposes. (auth)

1585 ANALYSIS OF VANADIUM IN MILK POWDER BY NEUTRON-ACTIVATION ANALYSIS USING A RAPID RADIOCHEMICAL SEPARATION OF 3.77-MINUTE VANADIUM-52. V. J. Molinski, Werner H. Wahl, and William H. Strain (Oak Ridge Gaseous Diffusion Plant, Oak Ridge, Tenn.). Trans. Am. Nucl. Soc., 6: 398(Nov. 1963).

1586 NEUTRON ACTIVATION CHROMATOGRAPHIC ANALYSIS IN BIOCHEMISTRY. Joseph M. Steim (Pennsylvania State Univ., University Park) and A. A. Benson. Trans. Am. Nucl. Soc., 6: 399-400(Nov. 1963).

1587 DETERMINATION OF CARBON IN SODIUM ISOTOPE-DILUTION MASS SPECTROMETRY. K. Y. Eng, R. A. Meyer, and C. D. Bingham (Atomics International, Canoga Park, Calif.). Trans. Am. Nucl. Soc., 6: 402-3 (Nov. 1963).

1588 PHOTOMETRIC DETERMINATION OF SCANDIUM BY CHLOROPHOSPHONAZO III IN WOLFRAMITE. I. P. Alimarin and V. I. Fadeeva. Vestn. Mosk. Univ., Ser. II, Khim., No. 4, 67-9(July-Aug. 1963). (In Russian)

An analysis of chlorophosphonazo III (2,7-bis(4 chloro-2-phosphonbenzylazo)-1,8-dihydroxynaphthalene-3,6-disulfonic acid) reaction with Sc and Th, Zr, Ti, Nb, Ta,

U and other rare earths showed that they form a strong intracomplex compound. Absorbtion spectra of chlorophosphonazo-III with Sc and its complexes are given. The determination of Sc was carried out at pH 2 to 4 and reaction sensitivity of 0.1 to 0.2 g/ml. (R.V.J.)

1589 X-RAY SPECTRAL ANALYSIS. V. P. Bykov and I. V. Sorokin (All-Union Research Inst. of Natural Resources, Academy of Sciences, USSR). Zavodsk. Lab., 29: 1065-6(1963). (In Russian)

Methods for the x-ray spectral analysis of Nb, Zr, and Ge solutions, with 5 to 7% accuracy, within 10 to 15 min were described. (R.V.J.)

1590 X-RAY SPECTRAL ANALYSIS OF MINERALS. V. P. Bykov and I. V. Sorokin (All-Union Research Inst. of Mineral Resources, Academy of Sciences, USSR). Zavodsk. Lab., 29: 1074-6(1963). (In Russian)

X-ray spectral analysis of minerals, using an automatic spectrometer, was described, and Nb_2O_5 concentrations in prepared specimens were determined with accuracies to 0.005%. (R.V.J.)

1591 APPLICATION OF FLUORESCENT X-RAY SPECTRAL METHOD FOR RARE EARTH ELEMENTS. V. K. Renev and V. I. Ganopolskii. Zavodsk. Lab., 29: 1076-7(1963). (In Russian)

Fluorescence x-ray analyses were made for rare earths and correlated with the line intensities of 50 standards. Relative errors were 5 to 10%. (R.V.J.)

1592 SIMULTANEOUS MICRODETERMINATION OF HYDROGEN, CARBON, AND URANIUM. M. K. Dzhamaletdinova. Zavodsk. Lab., 29: 1175-6(1963). (In Russian)

A gravimetric microanalysis was made of microquantities (3 to 5 mg) of carbon, hydrogen, and uranium in organic uranium compounds. Relative determination time was 35 to 40 min, order of error 0.2%. (R.V.J.)

1593 ANALYTICAL CHEMISTRY OF THE ACTINIDE ELEMENTS. Alfred J. Moses. A Pergamon Press Book. International Series of Monographs on Analytical Chemistry. New York, The MacMillan Company, 1963. 143p.

Nuclear properties and synthesis of the actinides and methods for the separation and determination of the actinides, such as nuclear methods, spectrophotometric, emission spectroscopy and mass spectrometry, electrochemical, x-ray, and fluorimetric methods, non-instrumental methods, and isotopic analysis of uranium and other actinides are discussed. Nuclear data, thermal neutron activation and fission cross sections, and standard oxidation potentials of actinides are appended. (P.C.H.)

1594 ISOTOPE TECHNOLOGY DEVELOPMENT. p.53-77 of "Isotopes and Radiation Technology. Vol. 1, No. 1."

A review is presented of current work on the use of isotopes in the new radio-release analytical technique and in neutron activation analysis. (D.L.C.)

1595 THE DETERMINATION OF THORIUM IN MONAZITE BY FLUORESCENT X-RAY SPECTROMETRY. M. C. Farquhar and M. M. English. 10p. (CONF-174-7)

From 12th Annual Conference Application of X-Ray Analysis, Denver, Aug. 1963.

A method is presented for the quantitative determination of thorium in monazite by fluorescent x-ray spectrometry. Strontium is used as an internal standard, and sample preparation consists of mechanically blending the finely ground (325-mesh) sample with reagent grade strontium carbonate. The prepared sample blend is packed into a sample cup and irradiated at 50 kv and 27 ma. A lithium fluoride analyzing crystal is used, and the intensity of the thorium L-alpha-1 and strontium K-alpha peaks are scaled. Replicate results agreed within 0.2% ThO_2 on six samples of monazite which contained from 4.4% to 6.8% ThO_2. The method was used to determine the thorium content of several rare earth materials which contained approximately 0.5% to 1.0% ThO_2. The results agree closely with values obtained by gamma-ray spectrometry. (auth)

1596 SPECTROGRAPHIC DETERMINATION OF BERYLLIUM IN OILFIELD WATERS USING A PLASMA ARC. A. Gene Collins and Cynthia A. Pearson (Bureau of Mines, Bartlesville, Okla.). 17p. (CONF-285-5)

From 7th Conference on Analytical Chemistry in Nuclear Technology, Gatlinburg, Tenn., Oct. 1963.

Geochemical studies of the distribution of the trace, minor, and major constituents of oilfield waters aid in the exploration for petroleum and other minerals, determination of the origin and distribution of oilfield waters and petroleum, and location of casing leaks and of water pollution sources. The determination of the beryllium and related data should be useful in these studies. An emission spectrographic method utilizing a plasma arc assembly for determining beryllium in oilfield waters, with a sensitivity permitting detection of less than 1 ppb, was developed. Beryllium was extracted from synthetic and natural oilfield waters with chloroform and acetylacetone. The extracts were aspirated directly into the plasma arc, and the beryllium emission intensity was recorded on photographic plates. (auth)

1597 ANALYSIS OF INSULATING POWDERS BY SPARK SOURCE MASS SPECTROMETRY. R. Brown and W. A. Wolstenholme. 13p. (CONF-74-22)

From 11th Annual Conference on Mass Spectrometry and Allied Topics, San Francisco, May 1963.

Insulating powders can be analyzed by spark-source mass spectrometry, by mixing them with pure graphite powder and forming electrodes in a die. Reproducible spectra are obtained, and the speed of analysis is comparable to that obtained when conducting solids are analyzed. The method is not limited to insulating powders. (auth)

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Refer also to abstract 2097.

1598 (AWRE-O-45/63) PERMEATION AND DIFFUSION OF HYDROGEN ISOTOPES AND HELIUM THROUGH POLYMERIC MATERIALS. F. P. Evans, R. Gibson, C. G. Hutcheson, and P. M. S. Jones (United Kingdom Atomic Energy Authority. Weapons Group. Atomic Weapons Research Establishment, Aldermaston, Berks, England). Oct. 1963. 22p.

The permeability of two epoxy resins, Ziegler polyethylene, and nylon, to hydrogen isotopes and helium was studied over the temperature range 20 to 55°C. Diffusion constants were deduced from time lag measurements for the epoxy resins. (auth)

1599 (BNL-7373) THE NATURE OF THE HYDROGEN BOND IN THE BIFLUORIDE ION. James A. Ibers (Brookhaven National Lab., Upton, N. Y.). [nd]. Contract AT-30-2-GEN-16. 12p. (CONF-232-2)

From International Colloquy on Neutron Diffusion and Diffraction, Grenoble, France, Sept. 1963.

An analysis of neutron diffraction data for $NaHF_2$ and $NaDF_2$ single crystals and a refinement of similar data for KHF_2 indicate that the F−H−F ion is linear and symmetric. The F−H−F, F−D−F, and F−H−F distances obtained for $NaHF_2$, $NaDF_2$, and KHF_2 were 2.264 ± 0.003, 2.265 ± 0.007, and 2.277 ± 0.006Å, respectively. The vibrations of the ion were also considered. (D.C.W.)

1600 (CEA-2315) DIFFUSION THERMIQUE. (Thermal Diffusion). A. Lemarechal (France. Commissariat à l'Énergie Atomique. Centre d'Études Nucléaires, Saclay). 1963. 39p.

The essential principles of thermal diffusion in the liquid and gaseous phases are considered. The macroscopic and molecular aspects of the thermal diffusion constant are reviewed, as well as the various measurement methods; the most important developments however concern the operation of the CLUSIUS and DICKEL thermogravitational column and its applications. (auth)

1601 (CEA-2326) PREPARATION D'UN OXYDE DE BERYLLIUM FRITTABLE PAR DECOMPOSITION DE L'HYDROXYDE. (Preparation of a Sinterable Beryllium Oxide Through Decomposition of Beryllium Hydroxide). Michel Bernier (France. Commissariat à l'Énergie Atomique. Centre d'Études Nucleaires, Saclay). 1963. 59p.

Thesis submitted to Université, Paris.

A study was attempted to isolate the factors which among the ones effective in the course of the preparation of the beryllium hydroxide and oxide and during the sintering have an influence on the final result: the density and homogeneity of the sintered body. Of the several varieties of hydroxides precipitated from a sulfate solution, the β-hydroxide only is always contamined with beryllium sulfate and cannot be purified even by thorough washing. It was noticed that those varieties of the hydroxide (gel, α, β) have different decomposition rates; this behavior is used to identify and even to measure the different species in (α,β) mixtures. The various hydroxides transmit to the resulting oxides the shape they had when precipitated. Accordingly, the history of the oxide is revealed by its behavior during its fabrication and sintering. By comparing the results of the sintering operation with the various measurements performed on the oxide powders, one is led to the conclusion that an oxide obtained from beryllium hydroxide is sinterable under vacuum if the following conditions are fulfilled: the particle size must lie between 0.1 and 0.2 μ and the $BeSO_4$ content of the powder must be less than 0.25 per cent wt (expressed as SO_3 BeO). The best fitting is obtained with the oxide issued from an α-hydroxide precipitated as very small aggregates and with a low sulfur content. It was observed that this is also the case for the oxide obtained by direct calcination of beryllium sulfate. (auth)

1602 (CONF-117-11) THERMODYNAMIC CONSIDERATIONS IN METAL-METAL SALT INTERACTIONS. L. E. Topol (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). [1963]. Contract AT(11-1)-Gen-8. 19p.

From American Chemical Society 145th National Meeting, New York, Sept. 1963.

The free energies of interaction between isolated metal atoms and the molten chloride of that metal were calculated from thermodynamic considerations. Based on the values of these standard free energies of interaction, metal-salt systems can be classified into two categories. First are those systems exhibiting relatively weak interaction energies (less than 30 kcal); these include primarily the mono- and divalent metals. In the second group are solutions with relatively strong interaction energies (greater than 40 kcal); these consist of the transition metals and the metals that are normally trivalent. Solutions of the first category appear to consist of strongly-solvated atoms whereas several of the systems in the second group are known to undergo chemical reaction to form a soluble lower-valent cation species in the melt. This classification of metal-salt systems in terms of weak or strong interactions is considered more reasonable than that based on a nonquantitative property such as subhalide formation. For example, it is shown that the interaction energies of systems containing known solid subhalides, e.g., Hg−$HgCl_2$ and Bi−$BiCl_3$, are no larger and in many cases much less than those for other systems with no known subhalide. (auth)

1603 (CONF-117-14) THE HEAT OF FORMATION OF ZIRCONIUM DIBORIDE BY FLUORINE BOMB CALORIMETRY. Gerald K. Johnson, Elliott Greenberg, John L. Margrave, and Ward N. Hubbard (Argonne National Lab., Ill.). May 1963. Contract W-31-109-eng-38. 7p.

From American Chemical Society 145th National Meeting, New York, Sept. 1963.

The heat of formation of $ZrB_{1.98}$ was determined by combustion in fluorine of a high-purity sample. A preliminary value of −71.5 ± 1.9 kcal/mole was obtained for $\Delta H_f(ZrB_{1.98})$. This value is in good agreement with the latest value of Trulson and Goldstein (−71.7 ± 2 kcal/mole). (auth)

1604 (CONF-126-19) REACTIONS OF XENON FLUORIDES WITH AQUEOUS SOLUTIONS AND THE ISOLATION OF STABLE PERXENATES. John G. Malm, Ben D. Holt, and Ralph W. Bane (Argonne National Lab., Ill.). [1963]. Contract W-31-109-eng-38. 14p.

From Conference on Noble Gas Compounds. Argonne, Ill., Apr. 1963.

Hydrolysis of XeF_2, XeF_4, and XeF_6 was carried out using NaOH solutions. The reactions for XeF_2 and XeF_4 were shown to be $XeF_2 + H_2O \rightarrow Xe + \frac{1}{2} O_2 + 2$ HF and $3\ XeF_4 + 6\ H_2O \rightarrow 2\ Xe + \frac{3}{2} O_2 + Xe(VI) + 6$ HF, respectively. For XeF_6, no free Xe or O_2 was immediately evolved. On standing, the Xe(VI) solutions precipitate a Xe(VIII) salt and evolve some free Xe. The salt, a sodium perxenate, was characterized, and the formula was found to be between $Na_4XeO_6 \cdot 2\ H_2O$ and $Na_8XeO_7 \cdot H_2O$. The stability of Xe(VIII) and (VI) solutions was studied. (D.L.C.)

1605 (HW-79033) VISIBLE AND INFRARED ABSORPTION SPECTRA OF URANIUM DIOXIDE. J. L. Bates (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Sept. 1963. Contract AT (45-1)-1350. 14p.

The absorption spectra for single crystal and polycrystalline UO_2 were measured between 0.6 and 15μ at room temperature. The spectrum for UO_2 resembles that of a typical semiconductor, opaque in the visible but transparent over a large portion of the infrared. The absorption edge is located at approximately 0.6μ (2.0 ev). A large optical window extends from 3 to 13μ. The absorption coefficient for single crystal UO_2 was determined between 1.5 and 15μ. A maximum value of 57 cm^{-1} was measured at 1.70μ with minimum values of 6 cm^{-1} at 2.75 and 8μ. The absorption coefficient of polycrystalline UO_2 at wavelengths less than 8μ is estimated to be ten times larger than for single crystal UO_2. (auth)

1606 (HW-79141) A THERMOBALANCE FOR STUDYING THE CHLORINATION OF PLUTONIUM DIOXIDE WITH

PHOSGENE. R. J. Sorenson (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Oct. 1963. Contract AT(45-1)-1350. 25p.

An automatic recording thermobalance for studying the chlorination of plutonium dioxide with phosgene is described. The highly toxic and corrosive nature of these materials imposed restrictions on the construction and operation of the thermobalance. The instrument operates on the deflection balance principle in which the extension of a precision quartz helix spring is measured by a linear variable differential transformer. Experimental results from the gas-solid reaction between phosgene and plutonium dioxide are discussed. (auth)

1607 (IP-603) ELECTROTRANSPORT IN SOME LIQUID METAL ALLOYS (thesis). John D. Verhoeven (Michigan. Univ., Ann Arbor. Coll. of Engineering). Jan. 1963. Contract AT(11-1)-771. 291p.

Recent theories on the electrolysis of metals, referred to as electrotransport, are reviewed. A literature survey of 165 references presents experimental data on self transport in pure solid metals, electrotransport in solid metals containing interstitial solutes and solid solution solutes, electrotransport in solid semiconductors and liquid metals, and the Haeffner effect. Two experimental techniques were developed for measuring the electric mobility in liquid metal alloys at elevated temperatures. With the first technique the mobility is measured in dilute solutions of two binary systems and four ternary systems using bismuth as the solvent. The mobility is measured as a function of composition and temperature in the Bi–Sn system with the second technique. The precision of the second technique gives a deviation of 1% at the 95% confidence level on a t distribution, for the average mobility of 8 measurements. A phenomenological description is presented and the data on Bi–Sn are converted to the effective valence, or charge, employing literature data for the mutual diffusion coefficient. Analysis of the data indicated the true charge of Sn in Bi to be +1.8 at 500°C. The data agree with the work of Belashchenko. (auth)

1608 (JAERI-4025) PURIFICATION OF HELIUM COOLANT. Keiichi Oshima, Keiji Naito, and Keiichi Nishida (Japan Atomic Energy Research Inst., Tokyo). Feb. 1963. 41p. (In Japanese)

The literature from 1955 to 1961 on the purification of helium coolant, especially on the separation of fission gases, is reviewed. The principle of gas purification, the separation of radioactive and nonradioactive gases, and purification systems for helium coolant are covered. 184 references. (D.C.W.)

1609 (KFK-163) IONENAUSTAUSCHEREIGENSCHAFTEN VON AMMONIUMMOLYBDATOPHOSPHAT UND ANDEREN SCHWERLÖSLICHEN VERBINDUNGEN DER PHOSPHORMOLYBDÄNSÄURE. (Ion Exchange Characteristics of Ammonium Molybdatophosphate and Other Difficultly Soluble Compounds of Phosphomolybdic Acid). Heinrich J. Schroeder (Kernforschungszentrum. Institut für Radiochemie, Karlsruhe, Germany). July 1963. 77p.

In the study of the ion exchange characteristics of ammonium molybdatophosphate (AMP) and other compounds of phosphomolybdic acid, the solubility, distribution coefficients, capacity, and types of interactions between multivalent cations and the phosphomolybdic acid salts were determined. The solubility of the ammonium and rubidium salts of phosphomolybdic acid in HNO_3 was determined in dependence on the HNO_3 concentration and time using tracer techniques. Measurements of the exchange velocity of carrier-free Cs^{137} or Y^{91} on AMP in pure acid solutions showed that the exchange is very rapid and is almost quantitative. The results of the measurements of the distribution coefficients of a series of elements on AMP in HNO_3 permitted several affinity series to be established: $K^+ < Rb^+ < Cs^+$; $X^{2+} < X^{3+}$; $X^{3+} < Rb^+$; $X^{3+} < Cs^+$, with $X^{2+} = Ca^{2+}$, Sr^{2+}, Ba^{2+}, Ra^{2+}, Sn^{2+}, and UO_2^{2+}, and $X^{3+} = Y^{3+}$ and Fe^{3+}. Equilibrium measurements were made with Cs^+, Sr^{2+}, and Y^{3+} on molybdatophosphates of ammonium, ribidium, cesium, and thallium; and 8-quinolinol capacity measurements were made using ammonium and thallium molybdatophosphate. In the study of the interactions of Sr or Y with Rb^{86}-labeled rubidium molybdatophosphate, it was found that Y and probably Sr are exchanged equimolecularly with respect to Rb. The mechanism for the exchange was given. (J.S.R.)

1610 (KR-52) THE CATIONIC SPECIES OF RUTHENIUMNITROSYL–NITRATO COMPLEXES. J. G. van Raaphorst and P. A. Deurloo (Norway. Institutt for Atomenergi, Kjeller). Oct. 1963. 20p.

The cationic species of the rutheniumnitrosyl–nitrato complexes in nitric acid solutions were separated by means of an ion exchange technique. The NO_3/Ru ratio was determined to identify them. The amount of cationic species in stock solutions was measured as a function of the nitric acid concentration of these solutions. The existence of two stereo-isomers of the dinitrato complex is established and discussed. (auth)

1611 (LA-2513) A METHOD FOR THE USE OF CATION EXCHANGE RESINS TO DETERMINE ASSOCIATION CONSTANTS OF CEROUS AND SULFATE IONS. L. A. Blatz (Los Alamos Scientific Lab., N. Mex.). Feb. 1961. Contract W-7405-eng-36. 28p.

The use of cation exchange resins for studying ionic equilibria in aqueous solutions of sulfate and M^{3+} ions is considered. The method and equations are developed for the system cerous and sulfate ions. More than one complex, exchange of the first complex with the resin, three methods of extrapolation to zero sulfate ion concentration at constant and varying ionic strengths, and some factors affecting precision under each of these headings are considered. Some previous work on this system is reviewed. (auth)

1612 (NLCO-890(p.39-44)) DEHYDRATION OF WINLO GREEN SALT IN HF. C. W. Huntington, A. E. Abbott, M. G. Mendel, and D. R. Spadafora (National Lead Co. of Ohio, Cincinnati).

Techniques to reduce the phosphorus content of Winlo green salt were studied. Laboratory thermobalance tests showed that one approach was to change the dehydrating medium from nitrogen to anhydrous HF. Methods were devised and evaluated in two plant tests which permitted the use of HF to reduce the phosphorus content of the salt without the serious nickel contamination formerly associated with HF dehydration. (auth)

1613 (ORNL-3488(p.18-20)) ISOLATION AND CHEMICAL PROPERTIES OF SYNTHETIC ELEMENTS. (Oak Ridge National Lab., Tenn.).

The Raman spectra of TcO_4^- (aq) and MoO_4^{2-} (aq) and of crystalline $KTcO_4$, $KReO_4$, Na_2MoO_4, Na_2WO_4, $Na_2MoO_4 \cdot 2H_2O$, and $Na_2WO_4 \cdot 2H_2O$ were measured. Infrared spectra of $KReO_4$, $Na_2MoO_4 \cdot 2H_2O$, and $Na_2WO_4 \cdot 2H_2O$ were also observed. Examination of all the spectra led to the conclusion that the structure of the aqueous pertechnetate ion is tetrahedral. (auth)

1614 (ORNL-3488(p.65-90)) CHEMISTRY OF AQUEOUS SYSTEMS. (Oak Ridge National Lab., Tenn.).

The optical absorptions of hydrolyzed uranyl perchlorate solutions at 4300 A, in conjunction with acidity measurements, were used to evaluate the formation quotients for the species $(UO_2)_2(OH)_2^{2+}$ and $(UO_2)_3(OH)_5^+$. The spectra over the wavelengths studied (3600 to 5000 A) were shown to be consistent with the scheme postulating these as the major hydrolyzed species. From equilibrium ultracentrifugation, acidity measurements, and comparison of Raman spectra of solids and solutions, it appears that the major aggregated species formed on the addition of acid to molybdate solutions, up to $1\frac{1}{2}$ hydrogen ions per molybdate, are heptameric and octameric. The second dissociation constant of deuteriosulfuric acid was computed from 25 to 225°C from data on the solubility of Ag_2SO_4 in D_2SO_4 solutions. In addition, the thermodynamic constants for the reaction $DSO_4^- = D^+ + SO_4^{2-}$ are presented. A comparison with the corresponding values for the H_2SO_4 system is given. The activity coefficient of HBr in HBr-KBr mixtures was studied to 150°C. At constant temperature and ionic strength the logarithm of the activity coefficient of HBr in the mixtures varies linearly with the molality of KBr. With the parameters describing this variation it is possible to calculate the activity coefficient of the KBr in the mixtures. It was found that the activity coefficient of KBr varies less with changing ionic strength and temperature than does the activity coefficient of HBr in the same mixtures. The activity coefficients of HCl and NaCl in HCl–NaCl mixtures were computed. The thermal stability (25 to 250°C) and absorbance in the wavelength range 0.2 to 2.0 μ of HNO_3 (0.07 to 4.0 f), H_2SO_4 (0.1 to 0.4 f), and $DClO_4$ (0.01 to 1.0 f) respectively, were investigated with the use of titanium cells with sapphire windows. Each of the acids reacts measurably with both of these materials at rates which increase with acidity and temperature. However, the acids are essentially transparent solvents for the spectrophotometry of inorganic ions up to at least 250°C in the indicated concentration and spectral ranges: HNO_3 (0 to 1.0 f; 0.6 to 1.2 μ), H_2SO_4 (0 to 0.2 f; 0.25 to 1.2 μ), and $DClO_4$ (0 to 1.0 f; 0.25 to 1.8 μ). A survey was completed of the cation exchange behavior of the elements in HCl and $HClO_4$ solutions with special emphasis on the high ionic strength range. Another survey was completed of the cation exchange behavior of the elements in 8.5 M $HClO_4$–0.5 M HCl–0.1 M HF, a medium found particularly useful for major group separations. The ion exchange behavior of approximately 15 elements in citrate media was examined. In continuing studies with inorganic ion exchangers and adsorbents, zirconium antimonate was found to have extremely high selectivity for strontium, rare-earth oxides were shown to have anion exchange properties, and heavy-metal sulfides were found to be remarkably fast materials for chromatographic applications. Osmotic and activity coefficients, measured by the gravimetric isopiestic vapor pressure technique, are reported and analyzed for tetramethyl-, tetraethyl-, tetrapropyl-, and tetrabutylammonium chlorides, bromides, and iodides. (auth)

1615 (ORNL-3488(p.123-8)) WATER RESEARCH PROGRAM. W. H. Baldwin, M. H. Lietzke, R. J. Raridon, et al. (Oak Ridge National Lab., Tenn.).

Special glass electrodes, in conjunction with Ag/AgCl electrodes, can be used for determination of activity coefficients of salts in aqueous media and mixed water-organic solvents. Activity coefficients of HBr and KBr in their mixtures were determined; their logarithm varies linearly with composition at constant ionic strength. Activity coefficients of NaCl in HCl–NaCl mixtures were computed from literature data. The dissociation constant of DSO_4^- was evaluated and compared with that of HSO_4^-. The activity coefficients of salts, particularly NaCl, were determined in a large number of water-organic mixtures over a broad composition range. Work was initiated on hyperfiltration studies of various types of membranes. A special ion exchange membrane was developed and tested; it combines good salt rejection properties with reasonable flow rates. A comprehensive theory of Faradaic processes in porous conducting electrodes was developed and measurements carried out on the Fe(II)–Fe(III) system in a variety of media. The electrochemistry of corrosion of polycrystalline zone-refined iron was investigated in chloride solutions as a function of temperature, acidity, and chloride ion concentration. Corrosion was relatively insensitive to salt concentration at all temperatures and acidities studied. An electrochemical pH-stat was developed which automatically controls the acidity of unbuffered solutions in the range pH 3 to 11. This pH-stat can also be used to directly measure rates of corrosion and in some instances can be applied to evaluation of acid constants of ions. (auth)

1616 (ORNL-3494) AN EXPERIMENTAL STUDY OF SORPTION OF URANIUM HEXAFLUORIDE BY SODIUM FLUORIDE PELLETS AND A MATHEMATICAL ANALYSIS OF DIFFUSION WITH SIMULTANEOUS REACTION. L. E. McNeese (Oak Ridge National Lab., Tenn.). Nov. 29, 1963. Contract W-7405-eng-26. 135p.

The removal of uranium hexafluoride from a gas stream containing uranium hexafluoride and nitrogen by a single layer of sodium fluoride pellets was investigated. Experimental data on the rate and extent of sorption were obtained in the temperature range 29 to 100 degrees centigrade and uranium hexafluoride concentration range 0.57 to 10.9 mole per cent uranium hexafluoride. The results of this study indicate that the rate controlling mechanisms are: transfer of uranium hexafluoride across a stagnant gas film surrounding the pellet, diffusion of gaseous uranium hexafluoride in the pores of the pellet, and diffusion of uranium hexafluoride through a layer of uranium hexafluoride-sodium fluoride complex covering the unreacted sodium fluoride in the interior of the pellet. The crystalline density of the complex, $UF_6 \cdot 2NaF$, was determined to be 4.13 grams per cubic centimeter which indicates that incomplete reaction of the sodium fluoride will occur for pellets in which the initial volume void fraction is less than 0.807. A useful model was devised to represent the sorption of uranium hexafluoride by a single pellet of sodium fluoride, and differential equations based on the model were written. A general method of solution of the partial differential equation describing simultaneous diffusion and irreversible reaction with variable diffusivity and reaction rate constant was derived for systems in which a steady-state type of solution is valid. The experimental data were correlated on the basis of the model with a root-mean-square error of 9.5 per cent for all points. The resulting computer code and associated data may be used for design of sorber systems such as fixed and moving beds. (auth)

1617 (PG-Report-519) ANALYTICAL METHOD FOR THE DETERMINATION OF POUR AND PACKING DENSITY OF URANIUM TETRAFLUORIDE AND URANIUM DIOXIDE. (United Kingdom Atomic Energy Authority. Production Group, Springfields, Lancs, England). 1963. 3p.

A known weight of sample is poured into a measuring cylinder under standard conditions and the volume oc-

cupied is recorded. The pour density is calculated from these figures. The sample is then packed by allowing the cylinder to fall a number of times under standard conditions and the volume occupied is again recorded. The packing density is calculated from this volume and the weight taken. (auth)

1618 (TID-19680) CRYSTALLOGRAPHIC REQUIREMENTS AND CONFIGURATIONAL ENTROPY IN B.C.C. HYDRIDES. Thomas R. P. Gibb, Jr. (Tufts Univ., Medford, Mass.). [1962]. Contract [At(30-1)-1355]. 17p.

The number of ways $\underline{w}$ in which foreign atoms or ions may be arranged in a BCC host lattice, is enumerated as a function of composition for structural units containing two host atoms. The result is shown to be simply related to $\underline{w}$ for a mol of substance, which leads directly to the configurational entropy. The relatively large contribution of configurational entropy to the free energy of BCC metallic hydrides renders accurate calculation of $\underline{w}$ particularly important for this class of compounds. It is shown that conventional (combinatorial) calculation of $\underline{w}$ leads to large errors when site-occupation is restricted, e.g., in the case where occupation of a given site renders the nearest sites unavailable. The value of $\underline{w}$ is obtained by actual enumeration for restricted occupancy of octahedral and of tetrahedral sites by foreign atoms X and the results presented as graphs of $\underline{w}$ vs $\underline{n}$ where $\underline{n}$ is the atomic ratio defined by $MX_{\underline{n}}$. A simple method of calculating $\underline{w}$ for restricted site-occupancy is derived heuristically and shown to give excellent results for the cases studied. (auth)

1619 (UCRL-10920) ELECTRON REPULSIONS IN COMPOUNDS OF NITROGEN, OXYGEN AND FLUORINE. William L. Jolly (California. Univ., Berkeley. Lawrence Radiation Lab.). Aug. 1963. Contract W-7405-eng-48. 13p. (CONF-117-12)

From American Chemical Society 145th National Meeting, New York, Sept. 1963.

By comparisons of bond energies and bond lengths, it is shown that single bonds of the type N-X, O-X, and F-X (where X is a very electronegative element) are abnormally weak, and that this weakening increases with increasing electronegativity of the atom X. It is pointed out that this bond weakening may be attributed to repulsions between the bonding electrons and lone-pair electrons. (auth)

1620 (UCRL-8839) ELECTRONIC ENERGY LEVELS AND CRYSTAL QUANTUM STATES OF Tm(IV). John B. Gruber and John G. Conway (California. Univ., Berkeley. Lawrence Radiation Lab.). Aug. 1959. Contract W-7405-eng-48. 20p.

Limited agreement was obtained between theory and experiment for $4f \rightarrow 4f$ transitions for Tm(IV) ($4f^{12}$). It is clear from the considerations that have appeared so far in the literature that intermediate coupling is important in the case of Tm(IV). Solutions of the intermediate field equations yield $\zeta_{4f} = 2700\ cm^{-1}$, $F_2 = 450\ cm^{-1}$, and $\chi = (\zeta)/F2 = 3$. Experimental agreement to $\pm 200\ cm^{-1}$ was obtained. (auth)

1621 DIFFUSION OF $H_2{}^{18}O$ MOLECULES IN CONCENTRATED AQUEOUS SOLUTIONS OF LITHIUM CHLORIDE AND CESIUM CHLORIDE AT 25°C. J. Tamás, S. Lengyel, and J. Giber (L. Eötvös Univ., Budapest). Acta Chim. Acad. Sci. Hung., 38: 225-32(1963).

A systematic and critical study of the microcapillary method of diffusion coefficient determination is reported. Error sources, accuracy, advantages, and disadvantages of the method were investigated. The variations of the method with and without stirring were compared in experimental studies. The lack of stirring turned out not to form new error sources but to increase reproducibility of the results. Using the microcapillary method without stirring the diffusion coefficient values of water molecules were measured in aqueous lithium and cesium chloride solutions, in almost the whole concentration range at 25°C. O^{18} was used as tracer, because the use of D and T is charged with considerable isotope effects, accorded mainly to H-bonds. (P.C.H.)

1622 THE TRANSPOSITION STRUCTURE OF NbAs AND OF SIMILAR MONOPHOSPHIDES AND ARSENIDES OF NIOBIUM AND TANTALUM. H. Boller and E. Parthé (Univ. of Pennsylvania, Philadelphia). Acta Cryst., 16: 1095-1101(Nov. 10, 1963).

Niobium arsenide NbAs was found to crystallize in a new structure type, which is a transposition structure variation of the WC structure type. NbAs is tetragonal with a = 3.45 and c = 11.67 Å. The space group is $I4_1md(C_{4v}^{11})$ with 4Nb in 4a with z = 0 and 4As in 4a with $z = {}^5/_{12}$. Other isotypic compounds are TaAs with a = 3.43 and c = 11.65 Å and 'β-NbP' with a = 3.33 and c = 11.37 Å. The previously proposed structure for α and β-NbP was proved to be wrong. Stoichiometric NbP or 'β-NbP' crystallizes in the NbAs structure, but P-deficient NbP_{1-x} has a partly disordered NbAs structure. The transposition is not as regular as in stoichiometric NbP. The degree of disorder depends nearly linearly on phosphorus deficiency. The new structure type was compared with other known monophosphide structure types. The concept of a structural transposition and its cancellation offers a new viewpoint for an explanation of the occurrence of more than one crystal structure for the same compound. (auth)

1623 THE STRUCTURE AND BIREFRINGENCE OF HAMBERGITE, $Be_2BO_3.OH$. W. H. Zachariasen, H. A. Plettinger, and M. Marezio (Univ. of Chicago and Argonne National Lab., Ill.). Acta Cryst., 16: 1144-6(Nov. 10, 1963).

$Be_2BO_3(OH)$ is orthorhombic with four molecules in a cell of dimensions a = 9.755, b = 12.201, c = 4.426 Å. The space group is Pbca with all atoms in general positions. The structure was redetermined with high precision (R = 0.04). Bond lengths are: Be–4O = 1.633, B–3O = 1.367, H–O = 0.93, H ... O = 2.04 Å. Refractive indices calculated from the structure agree well with measured values. (auth)

1624 ADSORPTION OF THE ELEMENTS ON INORGANIC ION EXCHANGERS FROM NITRATE MEDIA. William J. Maeck, Maxine E. Kussy, and James E. Rein (Phillips Petroleum Co., Idaho Falls, Idaho). Anal. Chem., 35: 2086-90(Dec. 1963).

The distribution coefficients of 60 metal ions were measured for four inorganic ion exchangers from nitrate media over the pH range of 1 to 5. The exchangers are hydrous zirconium oxide, zirconium phosphate, zirconium tungstate, and zirconium molybdate. The data are presented as plots of log distribution coefficient vs pH in a series of four periodic charts. Separations of analytical interest are presented. (auth)

1625 CONTRIBUTION TO A STUDY OF LITHIUM HYDROXIDE AND LITHIUM PEROXIDE. J. Beltrán, C. Guillem, and L. López Mateo (Universidad, Valencia). Anales Real Soc. Espan. Fis. Quim. (Madrid), Ser. B, 59: 421-6(June 1963). (In Spanish)

Methods for the preparation of lithium hydroxide, $Li(OH) \cdot H_2O$, and lithium peroxide are described. The lithium peroxide compound is prepared from lithium

hydroxide (in both hydrated and anhydrous forms) and hyperol dissolved in absolute ethyl alcohol as a source of hydrogen peroxide. (P.C.H.)

1626 THE MÖSSBAUER EFFECT AND ITS SIGNIFICANCE IN CHEMISTRY. E. Fluck, W. Kerler, and W. Neuwirth (Universitat, Heidelberg). Angew. Chem., Intern. Ed. Engl., 2: 277-95(June 1963).

The effect discovered by Mössbauer concerns the resonance fluorescence of so-called recoil-free γ radiation from atomic nuclei, and it depends on the state of the chemical bonding of the atoms. The latter influences the position of the energy level of the atomic nuclei, so that the energy required for excitation of resonance fluorescence is somewhat smaller or greater than the energy of the γ quanta emitted by the radiation source. In order to obtain resonance fluorescence, therefore, the radiation source and absorber have to be kept moving relative to each other. If the intensity of the resonance fluorescence is plotted against this relative velocity, Mössbauer spectra are obtained. The positions of the lines in these spectra make it possible to draw conclusions about the nature of the atom's bonds. The efficiency of this method is demonstrated by illustration with numerous Fe compounds. It was shown, for instance, that the Fe atoms in insoluble Prussian blue have well-defined oxidation levels. Turnbull's blue shows the identical spectrum. A structure could be ascribed to tri-Fe dodecacarbonyl that also explains the diamagnetism of the compound. The Mössbauer spectrum of this compound, it is shown, consists of three lines, the two outer ones corresponding. The quadrupole splitting computed from their distance apart amounts to 1.09 mm/sec. This spectrum is interpreted on the basis of a structural model in which the Fe atoms are arranged in a linear fashion and the two outer Fe atoms are equivalent to each other. The outer Fe atoms are arranged octahedrally in this structure, while the central Fe atom makes use of a tetrahedral d^3s-hybrid for its bonding. Accordingly, a positive field gradient and consequent splitting of the resonance line are to be expected for the two outer Fe atoms, at which four terminal CO groups are situated opposite two bridging CO groups, while the Fe atom at the center of the tetrahedron should yield a single resonance line. The slight broadening of the middle line in the spectrum of tri-Fe dodecacarbonyl can be easily understood as a result of a slight distortion of the tetrahedral bonds. The Mössbauer spectrum of $Fe(CO)_4I_2$ is also discussed. The spectra of several K ferrates are illustrated and interpreted, as is that of α-dipyridyl-$FeCl_3$ complex. (BBB)

1627 PREPARATION OF METALLIC PROMETHIUM. F. Weigel (Universität, Munich). Angew. Chem., Intern. Ed. Engl., 2: 326(June 1963).

A method is described for purification of Pm by reduction of PmF_3 in vacuo. Processed Pm from the Isotopes Division of Oak Ridge National Laboratory, used as starting material, contained ~50 C (60 mg) of Pm^{147} together with about 50 mg Sm, 40 mg Nd, and about 7 mg Am^{241}. The lanthanides were separted on Dowex 50 × 12 by elution with 0.5M ammonium α-hydroxyisobutyrate at pH 3.5 and 87°C. The Am was separated by absorption on Dowex 1 × 10 and elution of the Pm with 8M ammonium thiocyanate. After this separation, the purplish pink solution of Pm^3 in HNO_3 still contained about 17 C of Pm^{147}, and aliquot portions, each of 100 μl, were removed from it. The purplish pink PmF_3 was precipitated with HF, washed several times with distilled water, centrifuged, and the supernatant solution pipetted off. After drying for two days over P_2O_5, the PmF_3 had shrunk to a compact pellet. The pellet was transferred to the inner basket of a tantalum crucible system, and ~10 times its wt of pure Li was placed in the outer crucible; the whole unit was then closed with a tantalum stopper and suspended in the container vessel of a vacuum manifold. At 2.7×10^{-6} mm Hg pressure the system was heated by means of an induction heater. At 750°C, excess Li effused from the crucible system. The crucible was then maintained for periods of 2 min each at 800°, 980°, and 1090°C, and then cooled to room temperature over 1 hr and examined under the microscope. Promethium metal had separated as a solid bead which had fused onto the tantalum wires of the inner container and which had the appearance of a Nd bead obtained under similar conditions. Its mp was 1080 ± 10°C. Because of its high radioactivity (940 mC/mg), a glovebox was used for high vacuum operations involving Pm. (BBB)

1628 NEW RESULTS RELATIVE TO THE CRYSTALLOGRAPHIC STUDY OF THE SULFIDES, SELENIDES, AND TELLURIDES L_2X_3 OF THE RARE EARTH ELEMENTS, YTTRIUM, AND SCANDIUM. Jean Flahaut, Louis Domange, Micheline Guittard, Marie-Paule Pardo, and Madeleine Patrie. Compt. Rend., 257: 1530-3(Aug. 19, 1963). (In French)

The crystalline structure of the compounds L_2X_3 (L = La, Ce, Pr, Nd, Sm, Gd, Dy, Er, Yb, Lu, Y, and Sc, and X = S, Se, and Te) was studied. The seven crystalline types found are briefly described. There is a clear localization of the types. Calculations of the ratio of the anion ionic radius to the cation ionic radius were tabulated but gave no precise limits to the crystalline phases. (J.S.R.)

1629 RESEARCH ON THE CRYSTALLINE STRUCTURE OF CURITE. Jean Protas (C.N.R.S., Bellevue, France). Compt. Rend., 257: 1919-22(Sept. 23, 1963). (In French)

The structure of curite, $3PbO \cdot 8UO_3 \cdot 5H_2O$, was determined beginning with Patterson projections on the (001) and (100) planes and generalized Patterson projections obtained from hk 1 and hk 2 layers. The positions of the heavy atoms were determined by the method of least squares, applied to the hk 0, hk 1, hk 2, hk 4, and 0 kl reflections. The structure is composed of layers of U atoms whose mean plane is perpendicular to the a axis. The Pb atoms are distributed statistically between the layers. (tr-auth)

1630 ON PHASE TRANSFORMATIONS IN THE SYSTEMS $TiCl_4-POCl_3-AlCl_3$ ($NbCl_5$, $TaCl_5$). B. A. Voitovich and A. S. Barabanova. Dopovidi Akad. Nauk RSR, No. 8, 1068-72(1963). (In Ukrainian)

Phase transformation were studied in the systems $TiCl_4-NbCl_5-POCl_3$, $TiCl_4-TaCl_5-POCl_3$, and $TiCl_4-AlCl_3-POCl_3$, and the formation of the compounds $AlCl_3 \cdot POCl_3$, $2AlCl_3 \cdot 3POCl_3$, $TiCl_4-NbCl_5 \cdot 3POCl_3$, and $TiCl_4 \cdot TaCl_5 \cdot POCl_3$ was proved. The phase diagrams of the systems $TiCl_4-NbCl_5-POCl_3$ and $TiCl_4-TaCl_5-POCl_3$ consist of seven crystallization fields: $Nb(Ta)Cl_5$, $Nb(Ta)Cl_5 \cdot POCl_3$, $TiCl_4$, $TiCl_4 \cdot POCl_3$, $TiCl_4 \cdot 2POCl_3$, $TiCl_4 \cdot Nb(Ta)Cl_5 \cdot 3POCl_3$, and $POCl_3$. In the $TiCl_4-AlCl_3-POCl_3$ systems the crystallization fields are $AlCl_3$, $AlCl_3 \cdot POCl_3$, $2AlCl_3 \cdot 3POCl_3$, $TiCl_4$, $TiCl_4 \cdot POCl_3$, $TiCl_4 \cdot 2POCl_3$, and $POCl_3$. The chlorides of aluminum, niobium, and tantalum form more stable equimolecular compounds with phosphorus chlorate than titanium tetrachloride. This may be utilized for separating $POCl_3$ from $TiCl_4$. (auth)

1631 SURFACE REACTION BETWEEN UO_2 AND U_3O_8. A. M. Balzari and R. L. Colombo (FIAT, Turin). Energia Nucl. (Milan), 10: 505-6(Sept. 1963).

In previous studies it was found that when green pellets of UO_2 ceramic powder containing moderate amounts of U_3O_8 powder are sintered, the final product contains some oxidized forms derived form the fluorite UO_2 structure, but no residual U_3O_8. It was ascertained that the cubic or tetragonal phases developed directly on slight reduction within the orthorhomic U_3O_8 matrix. A fragment of fused UO_2 was included in a pressed pellet made with U_3O_8 and sintered. Some reduction occurred in the U_3O_8 matrix close to the interfaces with the UO_2 crystal. (M.C.G.)

1632 X-RAY CRYSTAL STRUCTURE AND SOME PROPERTIES OF URANYL PERCHLORATE-DIOXANE COMPLEX. P. Rama Murthy (Indian Inst. of Science, Bangalore). Indian J. Chem., 1: 491-2(Nov. 1963).

The electronic absorption spectra, x-ray powder diffraction pattern, and vapor pressure of uranyl perchlorate-dioxane complex, $UO_2(ClO_4)_2 \cdot 6H_2O\ 5C_4H_8O_2$ were studied with a view to determining the crystal system, unit cell dimensions, and the nature of binding between dioxane and uranyl perchlorate in the complex. The values of the force constant, K_{U-O} and U—O bond length of UO_2^{2+} were found to be 4.373×10^5 dynes/cm and 1.83Å, respectively, and the heat of disociation, ΔH, of dioxane in the complex was found to be 9.2 kcal/mole determined from vapor pressure measurements, showing thereby that dioxane is very loosely held in the complex. The x-ray diffraction pattern corresponds to the monoclinic crystal system with 4 moles/unit cell and having the parameters a = 21.10, b = 16.39, c = 8.206 Å, and $\beta = 87°5'$. (OTS)

1633 PHASE RELATIONSHIPS FOR THE $AgNO_3$–AgI–$AgIO_3$ SYSTEM. J. W. Lacksonen, W. H. Kirby, and C. E. Dryden (Ohio State Univ., Columbus). J. Chem. Eng. Data, 8: 524-5(Oct. 1963).

Temperature composition data for the binary $AgIO_3$–$AgNO_3$ are plotted. Above 65 weight % $AgIO_3$, a true solution could not be obtained at 300°C, the highest temperature used. A number of ternary compositions were also analyzed. The lowest melting eutectic occurred at a weight percent composition of 50% AgI–27% $AgNO_3$–23% $AgIO_3$ with a melting point of 76°C. (P.C.H.)

1634 ISOTOPIC EFFECTS IN THE DISSOCIATION OF TRIATOMIC MOLECULES BY ELECTRON IMPACT. I. AN EXAMPLE OF THE "π" EFFECT, THE DISSOCIATION $HOD^+ \rightarrow OD^+ + H$ OR $OH^+ + D$. Florence Fiquet-Fayard and Paul-Marie Guyon (Faculté des Sciences, Orsay, France). J. Chim. Phys., 60: 1069-75(Sept. 1963). (In French)

The formation of OH^+ and OD^+ in mixtures of heavy water (H_2O, HOD, and D_2O) was studied by mass spectroscopy. It was shown that the isotopic effect observed was entirely due to the HOD molecule, which is called the "π" effect. The fragmentation rate of D_2O is the same as that of H_2O within the precision limits of the measurements. The isotopic effect measured $(OD^+/OH^+)_{HOD} = 2.1 \pm 0.1$ is dependent on the energy of the incident electrons between 500 and 23 ev, but it decreases below 23 ev. (tr-auth)

1635 CURRENT-VOLTAGE CURVES FOR ZIRCONIUM AND URANIUM IN MOLTEN FLUORIDES. D. L. Manning (Oak Ridge National Lab., Tenn.) and Gleb Mamantov. J. Electroanal. Chem., 6: 328-9(Oct. 1963).

A cathodic wave for the reduction of Zr(IV) in molten LiF–NaF–KF (46.5-11.5-42 mole %) and an anodic wave for the oxidation of U(IV) in molten LiF–NaF–KF and also in molten $2LiF \cdot BeF_2$ were observed. The reduction wave for Zr at both Pt and W microelectrodes exhibited a half-wave potential of approximately −1.4 v vs the platinum quasi-reference electrode. The oxidation of U(IV) at a Pt microelectrode occurred at half-wave potentials of approximately +0.4 and +0.5 v vs the graphite and Pt quasi-reference electrode, respectively. In general, the correlation between the limiting current (wave heights) and the concentration of the electroactive species was erratic. (P.C.H.)

1636 THERMAL DECOMPOSITION OF EUROPIUM(III) OXALATE. A. Glasner, E. Levy, and M. Steinberg (Hebrew Univ., Jerusalem). J. Inorg. Nucl. Chem., 25: 1415-22(Nov. 1963).

It is shown that the first step in the thermal decomposition of europium(III) oxalate leads to reduction to the divalent state. In an oxidizing atmosphere the europium is reoxidized and continues decomposing gradually to Eu_2O_3 at 390°. In an atmosphere of CO_2, Eu(II)Ox is stabilized at 320°. In vacuum, $Eu(II)CO_3$ admixed with carbon (originating in disproportionation of CO) is obtained in the temperature range 360–420°. A unified mechanism for the decomposition of oxalates is proposed, in which a trace of carbon monoxide acts as catalytic agent in the reductive decomposition of oxalates of reducible metal ions. (auth)

1637 HEATS OF FORMATION OF $Pu_{(aq)}^{3+}$, $PuCl_{3(c)}$, $PuOCl_{(c)}$, $Am^{3+}_{(aq)}$, $AmCl_{3(c)}$ AND $AmOCl_{(c)}$. J. Fuger and B. B. Cunningham (Univ. of California, Berkeley). J. Inorg. Nucl. Chem., 25: 1423-9(Nov. 1963). (UCRL-10722)

The following heats of solution were measured: alpha plutonium in 6 M HCl, −138.90 ± 0.9; alpha plutonium in 1.5 M HCl, −138.65 ± 0.7; $PuCl_{3(c)}$ in 0.001 M $HClO_4$ −0.099 M NH_4ClO_4, −31.60 ± 0.35; $AmCl_{3(c)}$ in 1.5 M HCl, −30.60 ± 0.2; $AmCl_{3(c)}$ in 0.001 M HCl, −33.36 ± 0.25 kcal $mole^{-1}$, respectively. On combination with other thermodynamic data the results yield the following standard heats of formation at 298°K: $Pu^{3+}_{(aq)}$, −138.6 ± 0.7; $PuCl_{3(c)}$, −226.8 + 0.7; $PuOCl_{(c)}$, −219.7 ± 1; $Am^{3+}_{(aq)}$, −162.4 ± 3; $AmCl_{3(c)}$, −249.2 ± 3; $AmOCl_{(c)}$, −227.6 ± 3, all in kcal per mole. (auth)

1638 RATE LAWS FOR THE U(IV)–U(VI) EXCHANGE REACTION IN AQUEOUS–ORGANIC MIXED SOLVENT SYSTEMS. J. O. Wear (Sandia Lab., Albuquerque, N. Mex.). J. Inorg. Nucl. Chem., 25: 1445-55(Nov. 1963). (TID-18407; SCDC-3143)

Rate laws were written and are discussed for the U(IV)–U(VI) exchange reaction in mixed solvents: 30, 60, 90, and 98 volume % ethanol–water; 30, 60, 90, and 98 volume % ethylene glycol–water, and 30, 60, and 90 volume % acetone–water. (auth)

1639 THE MEAN-SQUARE AMPLITUDES OF INTERATOMIC DISTANCES IN HEXAFLUORIDE MOLECULES. M. Kimura and K. Kimura (Nagoya Univ., Japan). J. Mol. Spectry., 11: 368-77(Nov. 1963).

Possible values of force constants were estimated by using fundamental frequencies and a general quadratic potential function for hexafluorides of S, Se, Te, Mo, W, Re, Os, Ir, Pt, U, Np, and Pu. The root-mean-square amplitudes of interatomic distances were calculated from the force constants and fundamental frequencies. According to the magnitudes of root-mean-square amplitudes hexafluoride molecules are classified into the following groups: SF_6, SeF_6, and TeF_6 containing np electrons; molecules from MoF_6 to PtF_6 containing 4d or 5d electrons; and UF_6, NpF_6, and PuF_6 containing 5f electrons. (auth)

1640 ν_3 AND ν_1 BANDS OF THE NT_3 MOLECULE. Llewellyn H. Jones (Los Alamos Scientific Lab., N. Mex.), W. W. Brim, and K. Narahari Rao. J. Mol. Spectry., 11: 389-410(Nov. 1963).

The ν_3 band of the NT_3 molecule occurring at about 4.5μ was recorded with a high resolution spectrograph. The observed rotational structure was analyzed and the constants evaluated are $[B'_{(v_3)} - B'_{(\text{ground state})}] = -0.030_5\ cm^{-1}$; $\zeta_3 = 0.214$; $q = 0.007\ cm^{-1}$; and $\nu_0 = 2184.76\ cm^{-1}$. The ν_1 band whose Q branch was located at $2014.1\ cm^{-1}$ was found to be much weaker than the ν_3 band; these two bands are of comparable intensity in the NH_3 molecule. (auth)

1641 KINETICS OF ION EXCHANGE IN THE CHELATING RESIN BIO-CHELEX 100. I. THE EXCHANGE OF THE ALKALINE EARTH IONS. Carla Heitner-Wirguin and George Markovits (Hebrew Univ., Jerusalem). J. Phys. Chem., 67: 2263-6(Nov. 1963).

The exchange of the cations Ca, Sr, and Mg on the chelating resin Bio-chelex 100 in the hydrogen form was studied. The slow step that determines the rate of exchange of the ions is diffusion through the resin particle. The diffusion coefficients at two temperatures and the activation energies for the various cations were calculated. (auth)

1642 $NbB_{1.963}$: THE HEAT CAPACITY AND THERMODYNAMIC PROPERTIES FROM 5 TO 350°K. Edgar F. Westrum, Jr. (Univ. of Michigan, Ann Arbor) and Gerald A. Clay. J. Phys. Chem., 67: 2385-7(Nov. 1963).

The heat capacity of a zone-melted nonstoichiometric $NbB_{1.963}$ was measured by adiabatic cryogenic calorimetry and found to have a normal sigmoid temperature dependence without transitions or thermal anomalies. Values of the heat capacity at constant pressure (C_p), the entropy (S°), the enthalpy function ($H^\circ - H^\circ_0$), and the Gibbs free energy function ($-[G^\circ - H^\circ_0]/T$) are 11.42, 8.91, 5.433, and 3.478 cal/(gfm °K), respectively, at 298.15°K. (auth)

1643 THE HEATS OF FUSION OF SOME RARE EARTH METAL HALIDES. A. S. Dworkin and M. A. Bredig (Oak Ridge National Lab., Tenn.). J. Phys. Chem., 67: 2499-2500(Nov. 1963).

Values for the heat and entropy of fusion, heat content, and heat capacity of La, Pr, Nd, and Gd bromides and Gd, Ho, and Er chlorides are given. $LaBr_3$, $PrBr_3$, and $GdCl_3$, and $NdBr_3$ have similar entropies of fusion to those found for the chlorides of La, Pr, and Nd and the iodides of Ce and Pr. On the other hand, Ho and Er chlorides and $GdBr_3$ have unusually low entropies of fusion. The low entropy of fusion of $HoCl_3$, $ErCl_3$, and $GdBr_3$, in which the ionic radius $r_{M^{3+}}$ is greater than $r_{Al^{3+}}$, is in agreement with the fact that their melts are ionic like the crystals and like the melts of the lower rare earth trichlorides, such as $LaCl_3$. (P.C.H.)

1644 EFFECTS OF IMPURITIES ON THE LUMINESCENCE OF RARE EARTH CHELATES. M. L. Bhaumik and I. R. Tannenbaum (Electro-Optical Systems, Inc., Pasadena, Calif.). J. Phys. Chem., 67: 2500-1(Nov. 1963).

The effects of impurities on the luminescence of europium trisbenzoylacetonate (EuBA), europium trisdibenzoylmethide (EuDBM), and terbium trisacetylacetonate (TbAA) chelates were studied. An increased number of lines in the impure chelates was observed. Measurements of decay times supported the observation that the impure chelates consist of different species. The results show that the luminescence processes in the rare earth chelate is very sensitive to the presence of impurities. (P.C.H.)

1645 DIFFERENCES IN THE MOBILITIES OF LIKE CHARGE IONS IN MOLTEN SYSTEMS. A. Berlin (CEN, Saclay, France), F. Menes, S. Forcheri, and C. Monfrini. J. Phys. Chem., 67: 2505-6(Nov. 1963).

Ionic mobilities of cationic traces in alkaline earth halide melts and in the eutectics $NaNO_3-KNO_3$ and $NaNO_3-KNO_3-LiNO_3$ are reported. The observed mobilities of alkaline earth ions in solution in $NaNO_3-KNO_3$ at 270°C increase linearly as a function of their simple ionic radium, while the observed mobilities of the alkali ions in the $NaNO_3-KNO_3$ eutectic at 270°C decrease linearly with the increase in the ionic radius. The behavior of the mobilities of the alkaline earth ions is contrary to Stokes' law on mobilities according to which the mobilities should decrease as the radius increases. (P.C.H.)

1646 SPECTROPHOTOMETRIC STUDY OF MOLTEN LITHIUM METAL–LITHIUM CHLORIDE SOLUTIONS. J. P. Young (Oak Ridge National Lab., Tenn.). J. Phys. Chem., 67: 2507-8(Nov. 1963).

Spectrophotometric observations of Li–LiCl are reported. The Li–LiCl mixtures melted as visually opaque liquids, although light of wave lengths greater than 1400 mμ was transmitted. During the color transformation of the melt from opaque to colorless, the melt acquired a magenta color, and over the wave length range of 2.0 μ to 260 mμ, the solution at a temperature of 650°C exhibited a fairly broad absorption peak at 550 mμ. The colorless melt exhibited a cut-off at about 260 mμ. The concentration of lithium in opaque solution was found to be 1 mole %. An interesting point is that after the melt had decolorized, a small amount of Li (ca 0.04 mole %) was found to be present in the sample. (P.C.H.)

1647 NUCLEAR MAGNETIC RESONANCE SPECTROSCOPY. LONG-RANGE PHOSPHORUS-31–HYDROGEN-1 SPIN-SPIN COUPLING. Fred Kaplan, Guridial Singh, and Hans Zimmer (Univ. of Cincinnati). J. Phys. Chem., 67: 2509-10(Nov. 1963).

Examination of the nuclear magnetic resonance spectra of several phosphorus-containing compounds revealed the existence of long-range $P^{31}-H^1$ coupling through four bonds. Compounds that exhibited coupling contain the P–N–C–C–H system. Long range coupling was not observed in compounds containing the P–N–N–C–H system. (P.C.H.)

1648 QUANTITATIVE ELECTRODEPOSITION OF THORIUM AND URANIUM. W. Parker, H. Bildstein, and N. Getoff (Osterreichische Studiengesellschaft fur Atomenergie, Seibersdorf, Austria). Nature, 200: 457-8(Nov. 2, 1963).

Experiments concerning the quantitative electrodeposition of Th and U in the nitrate form: $Th(NO_3)_4 \cdot 4H_2O$ and $UO_2 \cdot 6H_2O$ were carried out using a stock solution having a concentration of 50 mg/ml in distilled water. Conditions found to be suitable for the quantitative deposition of Th and U nitrate were: voltage constant at 600 v; starting current for each deposition; Th, 4.0 m amp; U 0.7 m amp; temperature 20°C; starting pH of solution 2.89; final pH of solution, 2.70; time required for the quantitative deposition of Th and U, 30 and 90 min, respectively, that is, 100% yield = 1.25 mg of solid material present in solution. Yields were determined for the conditions specified. (P.C.H.)

1649 DIRECT EVIDENCE FOR ENERGY TRANSFER BETWEEN RARE EARTH IONS IN TERBIUM–EUROPIUM TUNGSTATES. W. W. Holloway, Jr., M. Kestigian, and R. Newman (Sperry Rand Research Center, Sudbury, Mass.). Phys. Rev. Letters, 11: 458-60(Nov. 15, 1963).

The transfer of excitation energy from one species of rare earth ion to another was directly observed in terbium europium tungstates. The experiment consisted of the absorption of monochromatic light in a terbium absorption line with a resulting emission of the red europium fluorescence. (C.E.S.)

1650 MÖSSBAUER EFFECT IN LIQUIDS: INFLUENCE OF DIFFUSION BROADENING. P. P. Craig and N. Sutin (Brookhaven National Lab., Upton, N. Y.). Phys. Rev. Letters, 11: 460-2(Nov. 15, 1963). (BNL-7391)

The radius of the diffusing object is determined from Mössbauer effect measurements on cobalt-57 chloride in glycerol and on cobalt-57 embedded in porphyrin and hemoglobin. It is shown that in the presence of large diffusion effects the massive molecules do not recoil independently. The recoil momentum is transmitted to the entire fluid mass. (C.E.S.)

1651 SPIN LATTICE RELAXATION IN RARE EARTH ETHYLSULPHATES. [PART] I. J. Van den Broek and L. C. Van der Marel (Kamerlingh Onnes Laboratorium, Leiden). Physica, 29: 948-64(Sept. 1963).

Results are described of Hartshorn bridge measurements on single crystals of cerium, neodymium, and gadolinium ethylsulphate. In cerium ethylsulphate the splitting between the two lower Kramers doublets is determined from the perpendicular susceptibility as being $\Lambda/k = 6.95 \pm 0.1°K$. Specific heat results agree with those of Meyer and Smith; for the observed excess specific heat a tentative explanation is suggested. Relaxation times do not show the expected exponential temperature dependence and are long compared with the values calculated from Orbach's theory; they are suggested to be lattice-bath relaxation times. In NdES the specific heat constant b is in good agreement with results of others. Double relaxations are found that disappear at high magnetic fields. They are suggested to be caused by the relatively large hyperfine splittings of the odd Nd isotopes. From the specific heat constant b in GdES it is concluded that the crystal field parameter b_4^0 in the pure salt should be about 15% smaller than in the diluted (GdLa) ethylsulphate. The relaxation times in GdES at low fields are isotropic and follow a T^{-7} law; the field dependence of τ for the perpendicular direction follows the Brons-Van Vleck formula with p = 0.05, for the parallel direction the field dependence differs from the Brons-Van Vleck formula. In Nd and Gd ethylsulphate reasonable agreement is found between relaxation times measured by the bridge method and those measured by microwave pulse saturation methods. (auth)

1652 REVISED MOLECULAR CONSTANTS FOR THE CH AND CD SPECTRA. R. H. Garstang (Univ. of London Observatory). Proc. Phys. Soc. (London), 82: 545-7(Oct. 1, 1963).

The previously published analyses of the CH and CD spectra were examined, some errors corrected, and revised vibrational constants obtained. As hitherto, the isotope relations for vibrational spectra had to be assumed to obtain the complete set of constants. The electronic energies for CH and CD are more nearly equal than earlier results indicated; an attempt to impose the exact equality of electronic energies did not lead to satisfactory results. (auth)

1653 EXTENSION OF THE $C^2\Sigma \rightarrow X^2\Sigma$ SYSTEM OF SrD. M. Aslam Khan (Univ. of Chicago). Proc. Phys. Soc. (London), 82: 564-71(Oct. 1, 1963).

The (1, 1), (1, 0), and (0, 1) bands of the $C^2\Sigma \rightarrow X^2\Sigma$ system of the SrD molecule were observed (in emission) and analyzed. Like the (0, 0) band of this system, these bands show multiple perturbations as well as a sharp breaking off of the branches in the upper state. These anomalies are discussed and the approximate values for the rotational constants of these bands were calculated. (auth)

1654 ULTRA-VIOLET SPECTRUM OF MgH AND MgD. M. Aslam Khan (Univ. of Chicago). Proc. Phys. Soc. (London), 82: 572-80(Oct. 1, 1963).

The 2819-, 2702-, and 2590-Å bands of MgH and MgD were investigated in absorption. It is shown that the 2819- and 2702-Å bands are the (0, 0) and (1, 0) transitions of the same system, while the 2590-Å band is the (0, 0) band of a different system. Rotational analyses are given for the (0, 0) and (1, 1) bands of MgD in the 2590-Å system and for the (1, 1) band of MgH in the 2819-Å system. (auth)

1655 BANDS OF NiH AND NiD IN THE VIOLET REGION OF THE SPECTRUM. E. Andersén, A. Lagerqvist, H. Neuhaus, and N. Aslund (Univ. of Stockholm). Proc. Phys. Soc. (London), 82: 637-8(Oct. 1, 1963).

Spectra of NiH and NiD are taken in absorption and photographed in a large concave grating spectrograph. Bands in the violet region of the spectrum were analyzed. They belong to a $^2\Delta - {}^2\Delta$ transition. $\Delta_{5/2} - \Delta_{5/2}$ sub-bands as well as $\Delta_{3/2} - \Delta_{3/2}$ sub-bands are investigated for both molecules, and for NiH also a $\Delta_{5/2} - \Delta_{3/2}$ band. The parameters for the 0–0 bands were derived. (auth)

1656 FLUORINE ELECTRON NUCLEAR DOUBLE RESONANCE (ENDOR) IN CALCIUM FLUORIDE. J. M. Baker and J. P. Hurrell (Clarendon Lab., Oxford). Proc. Phys. Soc. (London), 82: 742-56(Nov. 1, 1963).

The method of electron nuclear double resonance (ENDOR) was used to measure the interaction between a Eu^{2+} ion in CaF_2 and its ligand fluorine nuclei. Expressing the interaction in the form $A_s S \cdot I + A_p(3S_z I_z - S \cdot I)$, with z along the bond axis, the parameters are found to be $A_s = 2.23 \pm 0.01$ Mc and $A_p = +4.01 \pm 0.01$ Mc. The value of A_s is of the same sign as, but a factor of 4 smaller than, the value predicted theoretically by Freeman and Watson. Interactions with next nearest neighbor fluorine nuclei are found to be nearly dipolar. The possible line shift and line broadening of both fluorine and europium ENDOR due to high order effects in the fluorine and europium hyperfine interactions are discussed. (auth)

1657 THE KINETICS OF OXIDATION OF QUADRIVALENT URANIUM IONS BY HYDROGEN PEROXIDE IN PERCHLORIC AND SULPHURIC ACID SOLUTIONS. Jerzy Sobkowski (Univ. of Warsaw). Roczniki Chem., 37: 1019-24(1963).

The rate constants, activation energies, and frequency factors of uranium quadrivalent ion oxidation by hydrogen in perchloric and sulphuric acid solutions were determined using a spectrophotometric method. Particular attention was paid to the influence of anions on kinetics of the oxidation of Fe^{2+} ions. The results are discussed. (TCO)

1658 THERMOCHEMICAL PROPERTIES OF XENON DIFLUORIDE AND XENON TETRAFLUORIDE FROM MASS SPECTRA. Harry J. Svec and Gerald D. Flesch (Iowa State Univ., Ames). Science, 142: 954-5(Nov. 15, 1963). (IS-672)

The standard heats of formation for gaseous xenon tetrafluoride and xenon difluoride and the average strength of the bonds in these molecules were determined from appearance-potential data obtained with a mass spectrometer. The experimental values are compatible with theoretical estimates of these quantities. (auth)

1659 MOISTURE REMOVAL FROM GRAPHITES BY PURGING WITH DRY HELIUM BELOW 700°C. J. H. Shaffer and H. F. McDuffie (Oak Ridge National Lab., Tenn.). Trans. Am. Nucl. Soc., 6: 355-6(Nov. 1963).

1660 UO_2 AND ZrO_2 BEHAVIOR IN MOLTEN FLUORIDES. C. F. Baes, Jr., J. H. Shaffer, and H. F. McDuffie (Oak Ridge National Lab., Ill.). Trans. Am. Nucl. Soc., 6: 393(Nov. 1963).

1661 THE REACTIONS BETWEEN PuO_2 AND CARBON. R. E. Skavdahl (General Electric Co., Richland, Wash.). Trans. Am. Nucl. Soc., 6: 393-4(Nov. 1963).

1662 A CONTINUOUS COPRECIPITATION PROCESS FOR PRODUCTION OF REACTOR-GRADE $(U-Pu)O_2$ MIXED OXIDE POWDER. C. Caldwell, G. Ehrlich, J. Goodman, and H. Krake (Nuclear Materials and Equipment Corp., Apollo, Penna.). Trans. Am. Nucl. Soc., 6: 394 (Nov. 1963).

1663 PREPARATION OF UO_2/PuO_2/FISSIA FUEL ELEMENTS. M. D. Houston, R. Swain, J. Limpert, and O. Menis (Nuclear Materials and Equipment Co., Apollo, Penna.). Trans. Am. Nucl. Soc., 6: 394-5(Nov. 1963).

1664 REACTIONS OF POTASSIUM NIOBATES WITH METAL SALTS. V. I. Bezrukov, A. V. Lapitskii, and L. G. Vlasov. Vestn. Mosk. Univ., Ser. II, Khim., No. 4, 65-6(July-Aug. 1963). (In Russian)

Reactions of $KNbO_3$ with Cu^{2+}, Th^{4+}, Cr^{3+}, Co^{2+}, Ni^{2+}, and Ce^{3+} were analyzed. Preliminary data on solution transparency and conductometric and potentiometric titration indicate that the reactions with heavy metals formed complex compound. (R.V.J.)

1665 ON NIOBIUM AND TANTALUM OXALATE COMPLEXES. I. M. Gibalo and Ch'in Kuang Lung. Vestn. Mosk. Univ., Ser. II, Khim., No. 4, 73-4(July-Aug. 1963). (In Russian)

Stability and composition of Nb and Ta oxalates in saturated oxalic acid solutions were studied using EDE-10 π anionite in dynamic conditions. Simple formulas were developed for complex oxalates formed in oxalic acid solutions: $H[NbO(C_2O_4)_2]$ and $H[TaO(C_2O_4)_2]$. The compounds are stable at pH 1.3 to 5. (R.V.J.)

1666 ON UTILIZATION OF WATER VAPOR FOR PYROPHORICITY PREVENTION FOR UO_2 POWDERS. B. S. Brcic and M. Cuk (Nuclear Institute "Josef Stefan," Ljubljana, Yugoslavia). Vestn. Sloven. Kem. Drustva, 9: 55-6(1962). (In Slovenian)

It is shown that absorbed water vapor prevents the pyrophoricity of UO_2 powders. The protective covering is achieved outside the hot furnace zone by leading hydrogen saturated with water vapor (at water temperatures of 18 to 20°C) over the active UO_2 powder for a few hours. (tr-auth)

1667 THE s-f INTERACTION OF RARE-EARTH METALS. Fu-cho Pu and Chin-chi Cheng. Wu Li Hsueh Pao, 19: 503-23(Aug. 1963). (In Chinese)

By means of the algebraic method of the theory of angular momentum in quantum mechanics a detailed study is made for the model of s-f interaction of rare-earth metals. A general form of the hamiltonian of s-f interaction is derived. By means of the method of the theory of perturbation in operator form the general expression for the effective hamiltonian of f-f interaction through s-f interaction was obtained. Retaining terms to the second order of smallness, besides the isotropic exchange interaction the pseudo-dipole interaction is also obtained. On the basis of the results obtained, the magnetic crystalline anisotropy of the ferromagnetic phase of rare-earth metals was discussed. Experimental facts that might be explained by the results are indicated. (auth)

1668 CATHODIC PROCESSES IN THE DEPOSITION OF ZIRCONIUM FROM CHLORIDE MELTS. M. V. Smirnov, A. N. Baraboshkin, and V. E. Komarov (Inst. of Electro-chemistry, Academy of Sciences, USSR). Zh. Fiz. Khim., 37: 1669-76(Aug. 1963). (In Russian)

The polarization of a molybdenum cathode in a molten equimolal mixture of sodium and potassium chlorides containing from 0.65 to 4.0 mole % $ZrCl_2$ and from 0.7 to 5.3 mole % $ZrCl_4$ was investigated over the range of current densities from 10^{-4} to 10 amp/cm^2 and temperatures from 700 to 900°. It was found that deposition of metallic zirconium on the cathode is preceded by change in the zirconium ion charge from Zr^{4+} to Zr^{2+}. The residual recharging currents attain a magnitude of 0.1–0.2 amp/cm^2 for tetrachloride concentrations in the electrolyte of 16% by weight. Deposition of metallic zirconium from dichloride baths is shown to occur as the result of direct discharge of Zr^{2+} ions to the metal. The deposition potential of zirconium is by 1.1–1.2 v higher than that of the alkali metals. (auth)

1669 CATHODIC PROCESSES IN THE DEPOSITION OF ZIRCONIUM FROM MIXED CHLORIDE–FLUORIDE MELTS. M. V. Smirnov, A. N. Baraboshkin, and V. E. Komarov. Zh. Fiz. Khim., 37: 1677-81(Aug. 1963). (In Russian)

The polarization of a molybdenum cathode in fluoride–chloride melts into which zirconium was introduced either by anodic dissolution of the metal or as the fluorozirconate or the tetrachloride was investigated at 800° over the current density range of 10^{-4} to 5–10 amp/cm^2. It was found that both in the former and latter cases the deposition potential of zirconium greatly depends upon the fluorine ion content in the electrolyte, shifting in the negative direction with growth in this content. Deposition of the metal from melts containing tetravalent zirconium, for instance in the form of K_2ZrF_6, is accompanied by residual currents, mainly associated with its recharging to the trivalent state. (auth)

1670 DENSITY AND DEGREE OF DISORDER IN SOME SOLID PHASES OF VARYING COMPOSITION. E. I. Smagina and V. S. Kutsev (State Scientific Research Inst. and Design Inst. of Rare Earth Industry, USSR). Zh. Fiz. Khim., 37: 1813-17(Aug. 1963). (In Russian)

The density of zirconium nitrides of varying composition was determined by a pycnometric method and the dependence of the lattice periods upon the nitrogen content was investigated. The density increases with increase in x, but begins to diminish at $x > 0.9$, due to the presence of vacancies not only in the nitrogen sublattice but also in the zirconium sublattice. The degree of disorder of ZrN and also of the phases TiO and CrS was calculated from the dependence of the number of vacancies upon x. In general the pycnometric density is a function of the number of vacancies in the lattice, its volume, and the composition x. The density of real phases of varying composition can increase, diminish, or be depicted by curves with an extremum. (auth)

1671 ON THE ELECTROCHEMISTRY OF NIOBIUM. I. HYDROGEN OVERVOLTAGE ON NIOBIUM. A. L. Rotinyan and N. M. Kozhevnikova (Leningrad Inst. of Tech.). Zh. Fiz. Khim., 37: 1818-24(Aug. 1963). (In Russian)

The hydrogen overvoltage on niobium was found to diminish and the parameter of the crystal lattice to increase as the metal is saturated with hydrogen. The hydrogen overvoltage assumes a steady value after formation of the β-phase with lattice parameters $\alpha = 3.44-3.45$ kX. This

is attained by long term cathodic polarization. The dependence of the overvoltage upon lg i_K and upon the pH of the solution is in conformity with the slow discharge theory. The temperature coefficient of hydrogen overvoltage at moderate current densities is 1–1.5 mv/degree. The hydrogen exchange current and the standard hydrogen exchange current on niobium, as well as the activation energy of hydrogen discharge at the equilibrium potential, were calculated. (auth)

1672 KINETICS OF $Eu^{3+}-Eu^{2+}$ REDOX REACTION. L. P. Shul'gin and Yu. A. Koz'min. Zh. Fiz. Khim., 37: 1857-9(Aug. 1963). (In Russian)

A normal redox potential for Eu^{3+}/Eu^{2+} in hydrochloric acids at pH = 1 was −0.428 v. Variations of pH from 0 to 6 and introduction of rare earth elements do not affect the redox potential. The equilibrium constant of the Eu^{3+}/Eu^{2+} system and its temperature dependence were determined. The equilibrium constant is described by lg K = (3.125/T)–3.23. (R.V.J.)

1673 UNIT FOR MEASURING THE EXCHANGE CURRENT AND TRUE RATE OF THE ANODIC PROCESS ON AMALGAM ELECTRODES WITH THE AID OF RADIOACTIVE INDICATORS. V. V. Losev, M. A. Dembrovskii, and A. I. Molodov (Karpov Inst. of Physics and Chemistry). Zh. Fiz. Khim., 37: 1904-7(Aug. 1963). (In Russian)

A counting unit has been devised for the continuous automatic recording of rapid changes in the gamma radioactivity of a solution with time, consisting of a combination of scintillating counter with integrator and recording electronic potentiometer. With the aid of this unit on intensive stirring of the radioactive amalgam and solution and circulation of the latter through a side tube mounted in the unit, it is possible by means of radiochemical and electrochemical measurements to determine the exchange currents and the kinetics of the electrode processes on amalgam electrodes. (auth)

1674 DETERMINATION OF SURFACE AND INTERNAL STRUCTURAL WATER BY DEUTERIUM EXCHANGE WITH MASS SPECTROMETRIC CONTROL. L. T. Zhuravlev, A. V. Kiselev, V. P. Naidina, and A. L. Polyakov (Inst. of Physical Chemistry, Academy of Sciences, USSR and Moscow State Univ.). Zh. Fiz. Khim., 37: 2258-65 (Oct. 1963). (In Russian)

Deuterium exchange with mass spectrometric control showed that thermal treatment of KSK silica gel in vacuum liberates structural water not only from the surface but also from the bulk of the material. The method permits the concentration of hydroxyl groups on the surface to be determined. However reference of the entire loss caused by heating only to surface hydroxyl groups may lead to too high results. (auth)

1675 DETERMINATION OF THERMODYNAMIC CHARACTERISTICS OF FORMATION PROCESSES OF SOME POLYIODIDES USING OPTICAL DATA. I. P. Gorelov and V. V. Serebrennikov (Kuibyshev Tomsk State Univ., USSR). Zh. Fiz. Khim., 37: 2322-4(Oct. 1963). (In Russian)

Stability constants, variations of isobar potentials and enthalpy of polyiodide ion formation of alkali metals, ammonia, beryllium, magnesium, aluminum, scandium, yttrium, lanthanum, and lanthanides were calculated on the basis of optical density. (R.V.J.)

1676 VAPOR PRESSURE IN ZIRCONIUM TETRAFLUORIDE. N. P. Galkin, Yu. N. Tumanov, V. I. Tarasov, and Yu. D. Shishkov. Zh. Neorg. Khim., 8: 2021-3(Sept. 1963). (In Russian)

The Knudsen method (integral variant) was used for measuring the saturated vapor pressure of ZrF_4 α modification at 440 to 600°C. Experimental data are expressed by log $p_{mm\ Hg}$ = (10722/T) + 12.150. The heat of sublimation of ZrF_4 α modification is 49.05 kcal/mole. (R.V.J.)

1677 PROPERTIES OF RARE EARTH MONOSULFIDES. V. I. Marchenko and G. V. Samsonov (Inst. of Metal Ceramics and Special Alloys, Academy of Sciences, Ukrainian SSR). Zh. Neorg. Khim., 8: 2035-7(Sept. 1963). (In Russian)

Experimental studies were made of La, Ce, Nd, and Pr specific resistance at room temperature and mean resistance and thermal capacity at 20 to 1000°C. Thermal electron emission yield and emission coefficient at 800 to 1900°K were also studied as well as magnetic susceptibility and thermoelectromotive force at room temperature. (R.V.J.)

1678 ON CARBONATE BERYLLIUM COMPLEXES WITH HEXAMMINOCOBALT(III). A. V. Vinogradov, R. M. Apirina, and E. P. Cherstvenkova. Zh. Neorg. Khim., 8: 2062-4(Sept. 1963). (In Russian)

A gravimetric analysis was made of beryllium in beryllium concentrates, beryllium oxides, and alloys. The composition of precipitate produced by hexamminocobalt(III) chloride action on beryllium carbonate complex was in agreement with the Sen-Gupta formula. Conversion coefficient for precipitate weight into beryllium is 0.0395. The compound is unstable and transforms into an unknown compound at 60 to 65°. (R.V.J.)

1679 THERMOGRAVIMETRIC INVESTIGATION OF THORIUM THIOCYANATES. A. K. Molodkin and G. A. Skotnikova. Zh. Neorg. Khim., 8: 2080-7(Sept. 1963). (In Russian)

Thermogravimetric analysis was made of prepared thorium thiocyanate complexes $[Th(NCS)_4(H_2O)_4]$, Rb $[Th(NCS)_5(H_2O)_3]$ $(NH_4)_3$ $[Th(NCS)_7H_2O] \cdot nH_2O$, Me_4 $[Th(NCS)_8] \cdot 2\ H_2O$ where Me = NH_4^+, Rb^+, Cs^+, and K_4 $[Th(NCS)_8] \cdot 3.5\ H_2O$. At elevated temperatures all compounds exhibit dehydration followed by thiocyanate ion decomposition. A complete dehydration with simultaneous thiocyanate ion decomposition takes place in all compounds except $Rb_4Th(NCS)_8 \cdot 2\ H_2O$ and $Cs_4Th(NCS)_8 \cdot 2\ H_2O$. Thermal stability of thorium thiocyanate complexes depends on the nature of cations and increases according to: $(NH_4)_4Th(NCS)_8 \cdot 2\ H_2O < K_4Th(NCS)_8 \cdot 3.5\ H_2O < Rb_4Th(NCS)_8 \cdot 2\ H_2O < CsTh(NCS)_8 \cdot 2\ H_2O$; it increases also with the increase of the thiocyanate groups in $RbTh(NCS)_5 \cdot 3\ H_2O < Rb_4Th(NCS)_8 \cdot 2\ H_2O$ $(NH_4)_3Th(NCS)_7 \cdot 5\ H_2O < (NH_4)_4Th(NCS)_8 \cdot 2\ H_2O$. (R.V.J.)

1680 STRUCTURE OF OXONIUM BERYLLIUM HALIDE COMPOUNDS. K. N. Semenenko and N. Ya. Turova. Zh. Neorg. Khim., 8: 2093-8(Sept. 1963). (In Russian)

Crystal structure of oxonium beryllium halides was analyzed and interatomic distances and infrared spectra of oxonium beryllium chlorides are found. (R.V.J.)

1681 THERMAL CHEMISTRY OF COMPLEX FORMATION OF RARE EARTH IONS WITH ETHYLENEDIAMINETETRAACETATE. G. A. Prik. Zh. Neorg. Khim., 8: 2099-2102(Sept. 1963). (In Russian)

Calorimetric measurements were made of heat of formation of mixed $Ln(NO_3)_3$ solutions (where Ln = Nd, Sm, and Gd) and trilon B. Thermal effects and entropy variations in ethylenediaminetetraacetate complexes of neodymium are

−4.8 ± 0.1 and 55 kcal/mole/degrees, of samarium −4.6 ± 0.2 and 50 cal/mole/degrees, and gadolinium −2.5 ± 0.1 and 67 cal/mole/degrees. (R.V.J.)

1682 SOLUBILITY ISOTHERM FOR $ZrOCl_2-CaCl_2-HCl-H_2O$ AT 25°C. I. G. Kamaeva and V. V. Serebrennikov. Zh. Neorg. Khim., 8: 2151-4(Sept. 1963). (In Russian)

The solubility isotherm of $ZrOCl_2-CaCl_2-HCl-H_2O$ was studied at 25° and 0 to 20% HCl concentration. An analysis was made of the crystallized solid phases: $ZrOCl_2 \cdot 8\ H_2O$, $ZrOCl_2 \cdot 6\ H_2O$ (with isomorphous $CaCl_2$ admixture), $(ZrOCl_2)_2 \cdot CaCl_2 \cdot HCl \cdot 12\ H_2O$, $ZrOCl_2 \cdot CaCl_2 \cdot 0.5\ HCl \cdot 10\ H_2O$, and $\alpha + \beta$_ $CaCl \cdot 4\ H_2O$. (R.V.J.)

1683 DONOR PROPERTIES OF ESTER AND PHOSPHORYL OXYGEN IN TRIBUTYLPHOSPHATE. O. A. Osipov, V. I. Gaivoronskii, and A. A. Shvets. Zh. Neorg. Khim., 8: 2190-3(Sept. 1963). (In Russian)

Reactions of Ti, Zr, Sn, and Th tetrachlorides with tributyl phosphates were studied by an infrared method. It is shown that $TiCl_4$ with TBP forms two compounds with 1:2 and 2:2 ratio. The structure of the 2:2 ratio compound was analyzed. Simultaneous participation of ester and phosphoryl TBP oxygens was postulated and formation of a donor-acceptor bond was analyzed. The behavior of $TiCl_4$, $ZrCl_4$, $SnCl_4$, and $ThCl_4$ as TBP acceptors was investigated. (R.V.J.)

1684 SORPTION OF CERTAIN ELEMENTS BY CARBOXYL CATIONITES E. P. Kazantsev and A. N. Denisov (Kirov Polytechnic Inst., USSR). Zh. Neorg. Khim., 8: 2198-2205(Sept. 1963). (In Russian)

Sorption and elution of Fe^{3+}, Th^{4+}, UO_2^{2+}, Cu^{2+}, Be^{2+}, Ni^{2+}, and La^{3+} by carboxyl cationites SG-1, KB-4P-2, and KB-2 in H^+ form were studied as functions of pH at room temperature. It was found that ion sorption of the examined elements increased with pH. The sorption affinity of ions increased with the increase of pH and reduced according to: $Fe^{3+} > Cu^{2+} > Th^{4+} > UO_2^{2+} \geq Be^{2+} > La^{3+} > Ni^{2+} = Ca^{2+}$. It is also shown that a complete separation of Ni, U, and Th can be achieved by means of SG-1 in H^+ form. A satisfactory separation of Fe(III), Th, Be, and Cu can be made using carboxyl cationites, especially SG-1 and KB-2 × 2 in H^+ form. (R.V.J.)

1685 COMPLEX COMPOUNDS OF RARE EARTHS WITH 1,10-PHENANTHROLINE. N. L. Lobanov and V. A. Smirnova (Inst. of Chemistry, Academy of Sciences, Moldavian SSR). Zh. Neorg. Khim., 8: 2206-7(Sept. 1963). (In Russian)

Studies of complex compounds of La, Ce(III), Pr, Nd, and Sm nitrates and sulfates with 1,10-phenanthroline revealed new complexes of: $La(NO_3)_3 \cdot 2$ phen, $La_2(SO_4)_3 \cdot 2$ phen $\cdot 1.5\ H_2O$, $Ce(NO_3)_3 \cdot 2$ phen, $Ce_2(SO_4)_3 \cdot 2$ phen $\cdot 3.5\ H_2O$, $Pr(NO_3)_3 \cdot 2$ phen, $Pr_2(SO_4)_3 \cdot 2$ phen $\cdot 3.5\ H_2O$, $Nd(NO_3)_3 \cdot 2$ phen, $Nd_2(SO_4)_3 \cdot 2$ phen $\cdot 3.5\ H_2O$, $Sm(NO_3)_3 \cdot 2$ phen, and $Sm_2(SO_4)_3 \cdot 2$ phen $\cdot 1.5\ H_2O$. All compounds are soluble in cold water and alcohol and nitrate compounds are also soluble in hot water and are separated during cooling. (R.V.J.)

1686 COMPLEX COMPOUNDS OF RARE EARTH NITRATES WITH 2,2-PYRIDINE. N. I. Lobanov and V. A. Smirnova (Inst. of Chemistry, Academy of Sciences, Moldavian SSR). Zh. Neorg. Khim., 8: 2208-10(Sept. 1963). (In Russian)

Preparations were described of complex compounds of rare earth nitrates with 2,2 dipyridine: $Y(NO_3)_3 \cdot 2$ dipy, $Pr(NO_3)_3 \cdot 2$ dipy, $Eu(NO_3)_3 \cdot 2$ dipy, $Dy(NO_3)_3 \cdot 2$ dipy, $Tm(NO_3)_3 \cdot 2$ dipy, $La(NO_3)_3 \cdot 2$ dipy, $Nd(NO_3)_3 \cdot 2$ dipy, $Gd(NO_3)_3 \cdot 2$ dipy, $Ho(NO_3)_3 \cdot 2$ dipy, $Yb(NO_3)_3 \cdot 2$ dipy, $Ce(NO_3)_3 \cdot 2$ dipy, $Sm(NO_3)_3 \cdot 2$ dipy, $Tc(NO_3)_3 \cdot 2$ dipy, $Er(NO_3)_3 \cdot 2$ dipy, and $Lu(NO_3)_3 \cdot 2$ dipy. The prepared compounds do not contain any crystallized water and flare up and burn during heating. (R.V.J.)

1687 PROPERTIES OF THORIUM ACETATES. K. N. Kovalenko, D. V. Kazachenko, and O. N. Samsonova. Zh. Neorgan. Khim., 8: 2222-5(Oct. 1963). (In Russian)

Electric conductivity and pH of thorium tetra-acetate solutions were measured at concentrations from 0.00025 to 0.0080 mole/l and temperature of 25°C. Hydrolysis of $Th(CH_3COO)_4$ is equal to 84.8% at 25°C. The maximum equivalent electroconductivity of $Th(CH_3COO)$ is (86.3 $ohm^{-1} \cdot cm^2$) and Th ionic mobility at 25°C is (54.4 $ohm^{-1} \cdot cm^2$). Thermographic analysis of anhydrous thorium tetra-acetate revealed an endothermal effect at 289°. The density of the tetra-acetate is 2.464 g/cm^3 at 20°C. (R.V.J.)

1688 REACTIONS OF CARBONATE AND FLUORINE GROUPS IN THE INTERNAL SPHERE OF URANYL COMPLEXES. I. I. Chernyaev, G. V. Ellert, R. N. Shchelokov, and L. K. Shubochkin. Zh. Neorgan. Khim., 8: 2232-9(Oct. 1963). (In Russian)

Reactions of carbonate and fluorine groups in the internal sphere of uranyl complexes were studied using the following initial uranyl salts: diaquodefluorouranyl $[UO_2F_2(H_2O)_2]$, nonafluorodiuranylates $M_5[(UO_2)_2F_9]$, pentafluorodiuranylates $M_3[UO_2F_5]$, and carbonate salts $[UO_2CO_3]$, complex anion carbonates $M[UO_2(CO_3)OH(H_2O)_3]$, $M(UO_2)_2(CO_3)_3\ OH(H_2O)_5$, and $M_2[UO_2(CO_3)_2(H_2O)_2]$. New data were collected on thermal properties and molar electric conductivity of newly prepared salts. Reactions of complex uranyl fluorides with alkali metal carbonates, barium and guanidine were investigated. (R.V.J.)

1689 MOLECULAR REFRACTION OF THORIUM THIOCYANATES. A. K. Molodkin and G. A. Skotnikova (Kurnakov Inst. of General and Inorganic Chemistry, Academy of Sciences, USSR). Zh. Neorgan. Khim., 8: 2240-7(Oct. 1963). (In Russian)

An attempt was made at determining molecular refraction and density indices for $Rb_4[Th(NCS)_8] \cdot 2H_2O$, $Cs_4[Th(NCS)_8]\ 2H_2O$, $(NH_4)_4[Th(NCS)_8] \cdot 2H_2O$, $Rb[Th(NCS)_8]$, $Cs_4[Th(NCS)_8]$, and $[Th(NCS)_4(H_2O)_4]$ and, also refraction of $[Th(NCS)_8]^{4-}$ coordinates, SCN−Th−NCS, and Th−NCS and water bond for octathiocyanothorates. The obtained magnitudes for R_{H_2O}, R_{Th-NCS} and cationic refractions were used for calculating molecular refractions $K_4[Th(NCS)_8] \cdot 3.5H_2O$, $(NH_4)_3\ [Th(NCS)_7 \cdot H_2O]\ 4H_2O$, and $Rb[Th(NCS)_5(H_2O)_3]$. (R.V.J.)

1690 ZIRCONIUM OXALATE COMPLEXES. G. S. Bochkarev, L. M. Zaitsev, and V. N. Kozhenkova (Kurnakov Inst. of General and Inorganic Chemistry, Academy of Sciences, USSR). Zh. Neorgan. Khim., 8: 2248-53(Oct. 1963). (In Russian)

Complex zirconium oxalate compounds were classified and tri-, tetra-, and penta-zirconium oxalate with ammonia and tri-, and tetra-zirconium oxalates with potassium were prepared and analyzed. (R.V.J.)

1691 ON LANTHANUM, SAMARIUM, AND EUROPIUM ORTHOTANTALATES. E. I. Krylov and M. M. Pinaeva-Strelina (Kirov Ural Polytechnic Inst., USSR). Zh. Neorgan. Khim., 8: 2254-7(Oct. 1963). (In Russian)

Preparation of La, Sm, and Eu orthotantalates is described, and their structure, thermal stability, and magnetic properties are analyzed. A differential thermal analysis was made of oxide mixtures of $La_2O_3 : Ta_2O_5 =$

1:1 and pycnometric density of $LaTaO_4$, $SmTaO_4$, and $EuTaO_4$ was determined at 20°C as 7.9, 8.8, and 8.9 g/cm³, respectively. Measurements of magnetic susceptibility at 78, 194, and 289°K showed that $LaTaO_4$ is dimagnetic and $SmTaO_4$ and $EuTaO_4$ are paramagnetic. (R.V.J.)

1692 COMPLEX FORMATION OF YTTRIUM WITH ETHYLENEDIAMINETETRAACETIC ACID. I. V. Tananaev and G. S. Tereshin (Kurnakov Inst. of General and Inorganic Chemistry, Academy of Sciences, USSR). Zh. Neorgan. Khim., 8: 2258-70(Oct. 1963). (In Russian)

Physico-chemical analysis was made of reactions of yttrium with ethylenediaminetetraacetic acid (EDTA) in aqueous solutions with variable pH. It was found that yttrium and EDTA form complexes YE^- and HYE (in acid media), Y_2E^{2+} (in yttrium-saturated acid media) and hydroxy complexes with a ratio Y:E = 1.9:1 (in yttrium-saturated alkali media). Constants for acid dissociation $HYE: pK^H_{HYE} = 1.70$, instability constants $YE: pK_{YE} = 18.21$, and instability constant $Y_2E^{2+}: pK_{Y_2E} = 2.7 \pm 0.3$. (R.V.J.)

1693 REACTIONS OF NIOBIUM OXYCHLORIDES WITH ALKALI CHLORIDES AND THERMAL STABILITY OF PENTACHLOROOXYNIOBATES. I. S. Morozov and V. A. Krokhin. Zh. Neorgan. Khim., 8: 2376-80(Oct. 1963). (In Russian)

studies of niobium oxychloride reaction with alkali chlorides showed that at atmospheric pressure and 150 to 500°C temperature niobium oxychlorides do not react with NaCl. Niobium oxychlorides react with K, Rb, and Cs chlorides forming pentachlorooxyniobates Me_2NbOCl_5 and tetrachlorooxyniobates $MeNbOCl_4$ where Me is K, Rb, and Cs cations with melting points 500, 570, and 640°C, respectively. Melt diagrams were constructed for KCl–$NbOCl_3$ and CsCl–$NbOCl_3$. The vapor pressure of $NbOCl_3$ over pentachlorooxyniobates was studied as a function of temperature. It is shown that the stability decreases with the ion radius of compounds $Cs_2NbOCl_5 > Rb_2NbOCl_5 > K_2NbOCl_5$. Certain thermodynamic functions of pentachlorooxyniobates and tetrachlorooxyniobates were determined. (R.V.J.)

1694 INTRACOMPLEX URANYL COMPOUNDS WITH TRIDENTATE LIGANDS. V. V. Zelentsov. Zh. Neorgan. Khim., 8: 2412-13(Oct. 1963). (In Russian)

Synthesis and crystal structure of intracomplex uranyl compounds with salicylal-0-oxyanilinate and 5 bromosalicylal-5 nitro-2 oxyanilinate were studied. (R.V.J.)

1695 SOLUBILITY AND ACIDITY PROPERTIES OF TANTALUM AND NIOBIUM HYDROXIDES. A. K. Babko, V. V. Lukachina, and B. I. Nabivanets (Inst. of General and Inorganic Chemistry, Academy of Sciences, Ukrainian SSR). Zhur Neorgan. Khim., 8: 1839-45(Aug. 1963). (In Russian)

Solubility of freshly precipitated tantalum and niobium hydroxides was studied at $[H^+]$ from 1×10^{-11} to 6N (nitric acid media). It is shown that the isoelectric region of tantalum is at pH 9 to 2 and niobium at pH 7 to 0. The isoelectric region of tantalum solubility is 6.0×10^{-6} mole/l. and niobium 1.4×10^{-5} mole/l. Effects of H^+ and OH^- concentration on solubility of Ta and Nb acids were evaluated. It was revealed that Ta and Nb ion monomers were formed at the initial stages of solubility. Instability constants were calculated for Ta and Nb hydroxides and a diagram of their distribution between various hydrolyzed forms and acid solutions was constructed. (R.V.J.)

1696 PHYSICO-CHEMICAL PROPERTIES OF LANTHANUM, CERIUM, AND SAMARIUM HEXANITRONICKELATES WITH POTASSIUM. G. P. Alexandrov, Z. I. Iorysh, and Zh. M. Shlaen (Geological Inst. of Natural Fuels, Academy of Sciences, Ukrainian SSR). Zhur. Neorgan. Khim., 8: 1876-82(Aug. 1963). (In Russian)

X-ray analysis showed that mixed potassium rare-earth hexanitronickelates form solid solutions of the general formula $mKR[Ni(NO_2)_6] \cdot nK_4[Ni(NO_2)_6]$. The compounds crystallized into cubic syngony with variable lattice parameters depending on the ratio of $mKR[Ni(NO_2)_6]$ to $nK_4[Ni(NO_2)_6]$ variations. Specific weight and refractive indices of one rare earth hexanitronickelate diminish with an increase of n/m in the mixed salt molecule, while in rare earth mixtures they increase with transitions toward elements with smaller ionic radii. Thermal resistance of rare-earth hexanitronickelates also increased with higher accumulation of $K_4[Ni(NO_2)_6]$ molecules in mixed salt molecule (or the increase of n/m). (R.V.J.)

1697 STABILITY CONSTANTS FOR CATION COMPLEXES OF RARE EARTHS WITH GLUCONIC ACID. N. A. Kostromina (Inst. of General and Inorganic Chemistry, Academy of Sciences, Ukrainian SSR). Zhur. Neorgan. Khim., 8: 1900-5(Aug. 1963). (In Russian)

Potentiometric titration was carried out with La, Pr, Nd, Sm, Eu, Gd, Tb, Dy, Ho, Eu, Yb, Lu, and Y chlorides and gluconic acid at an ionic strength of 0.2 and 25°. Stability constants were calculated for equimolar content using the data on potentiometric titration at rare earth-gluconic acid concentration 5×10^{-3} mole/l. Stability constants of MA_2^+ complexes were also estimated for titration data at rare earth concentration 2×10^{-2} mole/l and rare earth HA ratio of 1:5. (R.V.J.)

1698 SOLUBILITY IN TERNARY WATER–SALT SYSTEMS CONTAINING CERIUM NITRATES AND ALKALI METAL NITRATES. E. F. Zhuravlev, A. D. Sheveleva, R. L. Bogdanovskaya, S. F. Kudryashev, and V. A. Shchurov (Perm State Univ., USSR). Zhur. Neorgan. Khim., 8: 1955-63(Aug. 1963). (In Russian)

The isothermal cross section method was used in the investigation of solubility in the systems: $Ce(NO_3)_3-H_2O$, $Ce(NO_3)_3-KNO_3-H_2O$, $Ce(NO_3)_3-RbNO_3-H_2O$, and $Ce(NO_3)_3-CsNO_3-H_2O$ at temperatures of 10, 20, and 30°C. The $Ce(NO_3)_3-NaNO_3-H_2O$ system proved to be a simple eutonic type system. Investigations of the ternary systems: $Ce(NO_3)_3-KNO_3-H_2O$, $Ce(NO_3)_3-RbNO_3-H_2O$, and $Ce(NO_3)_3-CsNO_3-H_2O$ showed the presence of binary nitrates $Ce(NO_3)_3 \cdot 2KNO_3 \cdot 2H_2O$, $Ce(NO_3)_3 \cdot 2RbNO_3 \cdot 4H_2O$, and $Ce(NO_3)_3 \cdot 2CsNO_3 \cdot 4H_2O$. The binary nitrates $Ce(NO_3)_3-2KNO_3 \cdot 2H_2O$ and $Ce(NO_3)_3 \cdot 2CsNO_3 \cdot 4H_2O$ dissolve in water congruently while $Ce(NO_3)_3 \cdot 2RbNO_3 \cdot 4H_2O$ dissolves in water incongruently at 10°C and congruently at 20 and 30°C. (R.V.J.)

1699 COMPLEX HYDROOXALATE COMPOUNDS OF URANYL PENTACIDO GROUP. I. I. Chernyaev and R. N. Shchelkov (Kurnakov Inst. of General and Inorganic Chemistry, Academy of Sciences, USSR). Zhur Neorgan. Khim., 8: 1990-1(Aug. 1963). (In Russian)

Potentiometric titration of various composition uranyl oxalate compounds using alkali showed that neutralization (or induction of hydroxogroups) takes place in dilute solutions with a molar ratio $U_2^{4+}:OH$ of 1:1 and 1:1.25. A scheme suggested for hydrolytic decomposition of oxalate compounds showed that an aquooxalatehydroxouranylate ion $[UO_2(C_2O_4)_2(OH)(H_2O)]^{3-}$ was formed in the first stages of the process in the case of diaquodioxalatouranylate ion. Various derivatives of aquodioxalatohydroxouranylate ion were synthesized into $K_3[UO_2(C_2O_4)_2(OH)(H_2O)] \cdot H_2O$ (potassium aquodioxalatohydroxouranylate) large prismatic

bright orange crystals, $(CN_3H_6)_6[UO_2(C_2O_4)_2(OH)(H_2O)]$ quanidone aquodioxalatohydroxouranylate long prismatic-shaped crystals, $[C_2H_4(NH_3)_2]_3[UO_2(C_2O_4)_2(OH)(H_2O)]_2 \cdot 2H_2O$ ethylenediammonium aquodioxalatohydroxouranylate then laminar crystals, and $[(C_2H_5)_2NH_2]_3[UO_2(C_2O_4)_2(OH)(H_2O)]$ diethylammonium aquodioxalatohydroxouranylate prismatic-shaped crystals. In the complexes obtained the hydroxogroup was potentiometrically titrated with acid. Chemical data are in agreement with the formulas. (R.V.J.)

1700 LUMINESCENCE OF URANIUM(VI) IN CONDENSED SODIUM PHOSPHATES AND THEIR SOLUTIONS. T. S. Dobrolyubskaya. Zhur. Neorgan. Khim., 8: 2004-5 (Aug. 1963). (In Russian)

Studies of U(IV) luminescence as function of structure in condensed activated sodium phosphates and their solutions showed that only calcium trimetaphosphate structure offers the optimum conditions for U_2^{2+} cation luminescence. (R.V.J.)

1701 THERMOCHEMICAL INVESTIGATIONS ABOVE 1000°K WITH THE MASS SPECTROMETER. T. P. J. H. Babeliowsky. Thesis, Amsterdam, Universiteit Amsterdam, 1962. 135p.

Description is given of the apparatus and the temperature determination by means of an optical pyrometer. A summary of the thermodynamic theory necessary for the understanding of the experiments is included. The relation between measured quantities and theory is compared. The method of effusion from a Knudsen cell in which chemical equilibrium was established and the method of direct evaporation from a solid surface in the form of a wire are also described. Some thermodynamical calculations are given on the behavior of CaO and of the system Pd + oxide at high temperatures. Measurements on calcium carbide and on wires of tantalum carbide are also discussed. (RCN)

1702 THE EFFECT OF GROUP IIIA TO VIA ELEMENTS AND THEIR OXIDES ON GRAPHITE OXIDATION. J. F. Rakszawski and W. E. Parker (Speer Carbon Co., Niagara Falls, N. Y.). 28p. (CONF-73-17)

From 6th Biennial Conference on Carbon, Pittsburgh, June 1963.

The effect of group IIIA to VIA elements and oxides on graphite oxidation was determined. Additives were molded with spectroscopically pure graphite powder. The concentration was maintained constant at 0.1 mole percent based on the element. The rate of reaction with 1 atm of air was measured at 700 and 800°C. Air flow rate from 2000 to 3000 cc/min had no effect on the oxidation rate of the pure graphite at 700, 750, and 800°C indicating that reaction was not occurring in Zone III. The calculated E_a of 54 kcal/mole suggested reaction in Zone I. Visual inspection of the rods after reaction substantiated this conclusion. The reaction was first order with respect to oxygen partial pressure at 700 and 800°C. B, B_2O_3, P, and P_2O_5 inhibited the oxidation of graphite at 700 and 800°C while the other elements and oxides catalyzed the reaction to various degrees. The reaction remained kinetically of the first order when inhibited. A systematic variation in reaction rates appears to follow the diagonals of the periodic relationship of the element from the upper left to the lower right. These variations can be correlated with average ionization energy or electron affinity. (auth)

1703 INTERACTION OF CARBON DIOXIDE WITH CARBON ADSORBENTS BELOW 400°C. V. R. Deitz, F. G. Carpenter, and R. G. Arnold (National Bureau of Standards, Washington, D. C.). 30p. (CONF-73-16)

From 6th Biennial Conference on Carbon, Pittsburgh, June 1963.

The adsorption of carbon dioxide on carbon adsorbents (FT carbon, coconut charcoal, acid-washed bone char) and adsorbents containing basic calcium phosphate (hydroxylapatite, bone char, ash of bone char) was studied. Special consideration was given to the pretreatment of the materials. The carbons equilibrated as rapidly as the temperature; the basic calcium phosphates showed a rapid initial adsorption followed by a very slow rate which continued for days. Linear adsorption isotherms were found on FT carbon and the isosteric heats varied slightly with coverage. The isotherms for the remaining materials had varying curvature and were for the most part in the same sequence as the estimated surface areas. The isosteric heats of carbon dioxide correlated very well with the magnitude of surface hydroxyl groups, an estimate of which was made from the chemical composition. There appeared to be three increasing levels of interaction: (1) pure physical adsorption; (2) an adsorption complex having "bicarbonate structure"; and (3) an adsorption complex having "carbonate structure." (auth)

1704 AN INVESTIGATION OF THE CRYSTAL STRUCTURES OF THE ALKALI-EARTH METAL HEXAMMINES. Hans J. Holland and F. W. Cagle, Jr. (Univ. of Utah, Salt Lake City). 16p. (CONF-117-7).

From American Chemical Society 145th National Meeting, New York, Sept. 1963.

The ammines of calcium, strontium, and barium were found to have body-centered cubic structures at –40°C. The ammonia molecules are arranged octahedrally about the metal atoms in the cell. The actual compositions and cell parameters of the compounds are variable, and the usual formula $M(NH_3)_6$ represents only an upper limit for the ammonia content, without solid solution of ammonia in the compound. (auth)

1705 MANUFACTURE OF ZIRCONIUM OXIDE FROM ZIRCON. John Kenneth Olby (to Associated Lead Manufacturers Ltd.). U. S. Patent 3,109,704. Nov. 5, 1963. Priority date May 24, 1960, Great Britain.

A process is given for manufacturing phosphorus-free ZrO_2 from zircon ore. The process comprises calcining a mixture of the ore and Na_2CO_3 or K_2CO_3, extracting the phosphorus from the alkali metal zirconyl silicate by NaOH or KOH, converting the zirconyl silicate into $ZrOCl_2$ by HCl treatment, and converting $ZrOCl_2$ into ZrO_2 by H_2SO_4 precipitation and calcination of the precipitate. When ZrO_2 prepared in this way is used to make blue ceramic stains, the resulting color is a turquoise blue as compared with the mauvish shade obtained when phosphorus-contaminated ZrO_2 is used. (D.L.C.)

1706 PREPARATION OF ALKALINE EARTH METAL PHOSPHATES. Peter Whitten Ranby and Henry Leonard Burrus (to Thorn Electrical Industries Ltd.). U. S. Patent 3,110,560. Nov. 12, 1963. Priority date July 13, 1959, Great Britain.

A method is given for preparing the hydrogen phosphates of Ca, Sr, Ba, Mg, Cd, and Mn with a uniform crystallinity for use in the manufacture of luminescent materials. The method comprises preparing a solution containing alkaline earth metal ions and phosphate ions at a pH low enough to prevent precipitation, adding urea or some other hydrolyzable amide to the solution, and heating the solution to hydrolyze the urea or amide and thus effect the homogeneous precipitation of the phosphate. In the case of calcium hydrogen phosphate, the precipitate recovered from a boil-

ing solution is in the anhydrous form, especially suitable for phosphor production, while other precipitation methods yield only hydrated salts. (D.L.C.)

Organic Chemistry

1707 (AD-292908) THE SYNTHESIS OF AMINO-1,2-DITHIACYCLANES. Annual Progress Report, September 1, 1961–August 31, 1962. Harry F. Herbrandson (Rensselaer Polytechnic Inst., Troy, N. Y.). Dec. 31, 1962. Contract DA-49-193-MD-2058. 10p.

Cyclic amino disulfides with varying degrees of ring-strain and related dimercaptoamines were prepared. Rearrangement of nitrogen mustard-like intermediates was prevented by blocking the nitrogen with the benzenesulfonyl group prior to the introduction of the sulfur-containing functions. If the nitrogen was not in a position propitious for ring closure and rearrangement, blocking of the nitrogen was unnecessary. Nor were rearrangements of concern when the amino group was introduced subsequent to the introduction of the sulfur functions. (auth)

1708 (IDO-11056) CATALYTIC HYDROCRACKING OF POLYPHENYL SYSTEMS FOR USE IN RECLAMATION OF ORGANIC NUCLEAR REACTOR COOLANT. D. A. Scola and R. Kafesjian (Monsanto Research Corp. Boston Labs., Everett, Mass.). June 30, 1963. Contracts AT(11-1)-705 and AT(10-1)-1088. 113p.

Laboratory studies on the catalytic hydrocracking of polyphenyls were conducted in an effort to develop a catalytic hydrocracking method to reclaim degraded terphenyl nuclear reactor coolant. Conditions necessary for hydrocracking polyphenyls are described along with a technical evaluation of the process and products. A preliminary economic evaluation of the various hydrocracking processes is presented. (auth)

1709 (IDO-11057) RECLAMATION OF POLYPHENYL NUCLEAR REACTOR COOLANT BY SOLVENT TREATMENT. D. A. Scola and J. S. Adams (Monsanto Research Corp. Boston Labs., Everett, Mass.). [1963]. Contracts AT(10-1)-1088 and AT(11-1)-705. 115p.

Laboratory studies were conducted to develop methods to reclaim degraded terphenyl nuclear reactor coolant. A solvent treatment process to reclaim high boiler or spent coolant is described. A preliminary evaluation of the reclamation process is presented. Technical evaluation of products as well as a theoretical analysis of the effects of reclaimed coolant on coolant decomposition rate and make-up rate is reported. A description of all experimental work is also given. (auth)

1710 (IDO-11058) STUDIES OF THE RECLAMATION OF ORGANIC NUCLEAR REACTOR COOLANT BY PARTIAL HYDROGENATION OF POLYPHENYLS. D. A. Scola and J. Adams (Monsanto Research Corp. Boston Labs., Everett, Mass.). May 15, 1963. Contract AT(10-1)-1088. 52p.

The partial hydrogenation of o-, m-, and p-terphenyl at high temperatures (200 to 275°C) and pressures (1500 to 2500 psig) was studied to determine the initial path of the hydrogenation. These model studies were extended to damaged nuclear reactor coolant (high boiler or polyphenyl) in an effort to develop a reclamation process. (auth)

1711 (ORNL-3488(p.55-64)) ORGANIC CHEMISTRY. (Oak Ridge National Lab., Tenn.).

It was found that the pinacol rearrangement of 2-endo-phenyl-2,3-exo-norbornanediol does not take place through a vinyl dehydration. The study of small secondary isotope effects, using the differential method, was extended to several new carbonyl compounds. The primary isotope effect of C^{14} in the formation of 2,4-dinitrophenylhydrazones was found to be independent of the nature of the radical attached to the carbonyl group. Irradiation of aroyl cyanides was found to produce benzils and cyanogen in two instances. Some nitriles proved to be resistant to radiation or to undergo dimerization. Several important modifications made to the method for dry combustion of C^{14} compounds greatly increased the rate of combustion. Compounds doubly labeled with C^{14} and tritium yield carbon dioxide containing negligible tritium contamination. The effect of sample size was evaluated. The acid-catalyzed reactions of 1,2,2-triphenylethanol and of 1,2,2-triphenylethyl acetate, labeled with deuterium and C^{14}, were studied. The irradiation of isophorone with ultraviolet light was found to produce several products, two of which were solid photodimers. The classical carbonium ion mechanism for the deamination of 1,2,2-triphenylethylamine and for the thermal decomposition of N-acetyl-N-nitroso-1,2,2-triphenylethylamine was supported by a mathematical analysis of the rate expressions for the reactions. Pyrolysis of tributyl phosphate, dibutylphosphoric acid, monobutylphosphoric acid, barium dibutylphosphate, and barium monobutylphosphate produced mixtures of butenes. The extent of isomerization to cis- and trans-butene-2 varied with the acidity of the mixture being pyrolyzed. The composition of the butenes obtained from any of the above-mentioned starting materials differed from the thermodynamic equilibrium mixture. The gas-chromatographic separation of a mixture of butene isomers and 1,3-butadiene was performed at 25°C using several high-boiling compounds supported on Celite. The most effective resolutions were obtained using aryl ethers modified by nitro or amine groups, aryl aldehydes and ethers, and an organic phosphorus compound. The butenes produced by pyrolysis of butyl phosphates were analyzed using a 13-ft column of o-nitrophenetole on Celite. (auth)

1712 (TID-19613) PROGRESS REPORT [ON ORGANOMETALLIC COMPOUNDS OF LANTHANIDES AND ACTINIDES], FEBRUARY 15–NOVEMBER 15, 1962. (Ethyl Corp. Research and Development Dept., Detroit). Contract AT(11-1)-999. 6p.

The synthesis of cyclopentadienyllanthanide chlorides was accomplished and the chlorides show good stability. Magnetic susceptibilities of the chlorides and their complexes were measured and evaluated. The substitution products of the dicyclopentadienyllanthanide chloride complexes were studied. (N.W.R.)

1713 NUCLEIC ACIDS COMPONENTS AND THEIR ANALOGUES. XXXVI. THE SYNTHESIS OF DEUTERATED URACIL AND THYMINE. C. Párkányi and F. Šorm (Inst. of Organic Chemistry and Biochemistry, Czechoslovak Academy of Sciences, Prague). Collection Czech. Chem. Commun., 28: 2491-2500(Sept. 1963).

The preparation of the stably deuterated 5-bromouracil-6-$\underline{d}$, uracil-5-$\underline{d}$, uracil-6-$\underline{d}$, uracil-5,6-$\underline{d}_2$, 5,6-dihydrouracil-5,6-$\underline{d}_2$, thymine-α-$\underline{d}$, and thymine-6-$\underline{d}$ is described. Uracil-1,3-$\underline{d}_2$ and thymine-1,3-$\underline{d}_2$ containing loosely bound deuterium atoms were prepared by exchange reactions. Methods for the preparation of diethyl malate-α,O-$\underline{d}_2$ and ethanol-$\underline{d}$ are also described. Some syntheses of uracil were modified. (auth)

1714 ELECTROPHILIC ADDITION TO OLEFINS. III. THE STEREOCHEMISTRY OF ADDITION OF DEUTERIUM BROMIDE TO 1-PHENYLPROPENE. Michael

J. S. Dewar and Robert C. Fahey (Univ. of Chicago). J. Am. Chem. Soc., 85: 3645-8(Nov. 20, 1963).

Studies were made to determine the sterochemistry of the polar addition of hydrogen bromide to an acyclic olefin. It was found that both cis- and trans-1-phenylpropene add deuterium bromide in methylene chloride at 0° in the presence of 2,6-di-tert-butylphenol to give 1-bromo-1-phenylpropane-2-d_1, the polar addition product. With each of the isomeric olefins 88 ± 2% cis-addition was found. The results are interpreted in terms of a mechanism, involving ion pair intermediates, proposed for addition of hydrogen halides to olefins. (auth)

1715 ABSORPTION SPECTRA OF SOME DEUTERATED COMPOUNDS BETWEEN 2 AND 15 MICRONS. Monique Margottin-Maclou and Madeleine Corval (Faculté des Sciences, Paris). J. Chim. Phys., 60: 1044-6(Sept. 1963). (In French)

The absorption spectra between 2 and 15 μ of some deuterated compounds (methyl, ethyl, and isopropyl alcohols, acetone, and acetic acid) were determined. The frequencies of the most intense absorption bands were given. (tr-auth)

1716 EXCITATION OF π ELECTRONS IN BENZENE BY ELECTRON IMPACT. Michio Matsuzawa (Tokyo Univ.). J. Phys. Soc. Japan, 18: 1473-6(Oct. 1963).

Effective cross sections averaged over all directions of an incident electron were calculated for the excitations to the lower excited levels of π electrons in benzene using Born's approximation with the simple free electron model for π electrons. The results show that π electrons in benzene are quite easily excited to the lowest group of excited levels by electrons. (auth)

1717 MOLECULAR VIBRATIONS OF QUINONES. I. FERMI RESONANCE INVOLVING THE CARBONYL STRETCH IN p-BENZOQUINONE AND ITS ISOTOPIC DERIVATIVES. Edwin D. Becker, Herman Ziffer, and Elliot Charney (National Inst. of Arthritis and Metabolic Diseases, Bethesda, Md.). Spectrochim. Acta, 19: 1871-6(Nov. 1963).

Infrared spectra in the region 1550–1700 cm^{-1} are reported for p-benzoquinone, four of its deuterated derivatives, and two derivatives containing O^{18}. Changes in the spectra with isotopic substitution and with solvent demonstrate conclusively the presence of Fermi resonance in quinone, quinone-d_4, and quinone-2,5-d_2. A hot band, suggested recently as accounting for one of the three bands in this region in ordinary quinone, does not appear in the isotopic species. (auth)

1718 THE Sn^{117}–H AND Sn^{119}–H COUPLING CONSTANTS AND THE DIRECT MEASUREMENT OF J_{HH} IN DIETHYLTIN COMPOUNDS. W. Gerrard, J. B. Leane, E. F. Mooney, and R. G. Rees (Northern Polytechnic, London). Spectrochim. Acta, 19: 1964-5(Nov. 1963).

Nuclear magnetic resonance spectra of dimethoxy diethyltin and diethyltin dichloride were recorded at 40 Mc/s using 1.5 M solutions of the tin compounds in CCl_4. In diethyltin compounds the Sn–H couplings give rise to two A_2B_3 patterns on either side of the main resonance, each component being doubled due to the presence of the two tin isotopes. In the dimethoxy compound the methylene resonance occurs at 2.3 c/s, to high field of the methyl resonance, and consequently the two resonances occur together to give rise to a broad line. In the dichloride the methylene resonance occurs at 14.6 c/s to low field of the methyl resonance. (P.C.H.)

1719 KINETICS OF THE DEHYDROGENATION AND DEHYDRATION OF ISOPROPYL ALCOHOL AND THE DEHYDROGENATION OF TETRALIN ON LANTHANUM OXIDE. A. A. Tolstopyatova, A. A. Balandin, and Ch'i-tsu'an Yü (Inst. of Organic Chemistry, Academy of Sciences, USSR). Zh. Fiz. Khim., 37: 2220-7(Oct. 1963). (In Russian)

All the relative adsorption coefficients of the dehydrogenation and dehydration products of isopropyl alcohol and dehydrogenation products of tetralin are temperature-dependent. The inhibiting action of the products, propylene, water, and acetone in the isopropyl alcohol reaction and hydrogen in the tetralin reaction diminishes as the temperature is raised. Acetone and water possess a relatively high inhibiting effect. The bond energies of C, H, and O with La_2O_3 were determined by means of the kinetic method from the activation energies. It was found that $Q_{C-Cat} < Q_{H-Cat} < Q_{O-Cat}$. (auth)

1720 INFRARED SPECTRA OF TRANSITION METAL ALKOXIDES. C. T. Lynch, K. S. Mazdiyasni, J. S. Smith, and W. J. Crawford (Air Force Materials Lab., Wright-Patterson AFB, Ohio). 29p. (CONF-117-15).

From American Chemical Society 145th National Meeting, New York, Sept. 1963.

The preparation and infrared spectra of the triisopropoxides of B, Al, Y, and P; the tetraisopropoxides of Ti, Zr, Hf, and Th; tert-butyl alcohol; tert-butylacetate; the tetra-tert-butoxides of Si, Ti, Zr, and Hf; and the tri-tert-butoxide of Al are studied. (T.F.H.)

1721 INTRAMOLECULAR ISOTOPE EFFECTS IN HYDROCARBON MASS SPECTRA. D. P. Stevenson and J. H. Schachtschneider (Shell Development Co., Emeryville, Calif.). 13p. (CONF-296-2)

From Symposium on Unimolecular Reactions in the Mass Spectrometer and Related Topics in Chemical Kinetics, Salt Lake City, July 1963.

Approximate calculations based on the quasi-equilibrium rate theory of the origin of mass spectra are shown to lead to an approximately correct magnitude for the intramolecular (π^-) isotope effect on C–H bond dissociation probabilities of various deuterohydrocarbons. (auth)

Radiation Chemistry and Radiochemistry

Refer also to abstracts 2118 and 2119.

1722 (ASD-TDR-62-540) A STUDY OF FREE RADICALS AND OTHER INTERMEDIATE SPECIES AND INTERNAL ENERGY TRANSFER PROCESSES IN IRRADIATED CHEMICAL SYSTEMS. P. Y. Feng and B. K. Krotoszynski (Illinois Inst. of Tech., Chicago. Armour Research Foundation). Sept. 1962. 45p. (AD-288920)

A study was made of the role of internal energy transfer processes in radiation chemical reactions involving free radicals and other intermediate species, using a series of alkyl iodides with different carbon chain lengths as the experimental systems. It was found that, (1) with increasing size of the alkyl group in a homologous series, for example the 1-iodoalkanes, the extent of C–I bond rupture decreases regularly, whereas both the H_2 and the HI yields increase; (2) products with practically identical yields are formed in the radiolyses of two systems with similar elemental compositions, one consisting of pure $C_{16}H_{33}I$, and the other an equimolecular mixture of C_8H_{18} and $C_8H_{17}I$. Analysis of these results, together with those available in the literature, show that energy initially localized else-

where in an alkyl iodide molecule cannot efficiently cause C–I bond breakage despite the latter's low bond strength, i.e. internal energy transfer does not play an important role in these reactions. Instead, it is concluded that the product yields are dependent on the effective electron fractions of the various groups in the irradiated system, a parameter which permits the quantitative correlation of the outcomes of the radiolytic reactions investigated in this program. (auth)

1723 (NP-13190) RADIOCHEMISCHES PRAKTIUM—BESCHREIBUNG DER PRAKTIKUMSVERSUCHE. (Radiochemical Practices—Description of Laboratory Experiments). Karl-Erich Seyb (Mainz. Universität. Institut für Anorganische Chemie und Kernchemie). 1963. 109p.

The laboratory manual for the radiochemical laboratory at the Institut für Anorganische Chemie und Kernchemie is presented. The experiments given are operation of a G-M counter installation, determination of the characteristics of a G-M counter, preparation of standards, determination of the zero effect, determination of the dead time, errors in radioactive measurements, monitoring of the measurement installation by statistical tests, radiochemical working rules, preparation of radioactive measurement samples, fixation of radioactive preparation, decay and formation of radioisotopes, preparation of radioisotopes by neutron activation, analysis of complex decay curves, determination of the range of β radiation, absorption of γ radiation, radiation doses and shielding, self-absorption and back scattering of β radiation, geometry of measurement positions, characteristics of proportional counters, measurement with scintillation counters, effect of surface charge, foreigh ions, and "hold-back" carriers on adsorption of radioisotopes, separation of radioisotopes, radiocolloids, study of the Szilard-Chalmers reaction, study of electron exchange, and activation analysis of Mn traces in Al. (J.S.R.)

1724 (ORNL-3385(p.6-8)) SOL-GEL PROCESS DEVELOPMENT. O. C. Dean, A. T. Kleinsteuber, J. W. Snider, C. C. Haws, and P. A. Haas (Oak Ridge National Lab., Tenn.).

The sol-gel process, developed for the preparation of thoria or uranium oxide—thorium oxide particles suitable for filling nuclear reactor fuel elements by vibratory compaction, was successfully scaled up to the preparation of 15 kg per batch. Starting with the products of the Thorex process (uranyl nitrate and thorium nitrate), the process produces the dense oxides in four steps that can be readily carried out behind shielding. Each unit operation required for the sol-gel process was demonstrated at full scale. In the course of these studies, materials were made available for fuel element fabrication development and for in-pile testing of sol-gel-prepared materials. In the rotary denitrator, batches of thorium nitrate containing 15 kg of ThO_2 were dehydrated in heated air as the temperature was increased to 180°C, and then denitrated in superheated steam as the temperature was increased to 475°C and held for 1 hr. The design and operation of the calciner was successful and trouble-free. More than 400 kg of highly dispersible ThO_2 that had a reproducible residual NO_3^-/ThO_2 mole ratio of from 0.025 to 0.03 was prepared. Uranium oxide—thorium oxide sol was prepared in a specially-designed and developed critically safe slab tank. A precisely measured volume of uranyl nitrate solution, analyzed for uranium and nitrate content, was added to water and circulated through the tank and a heater. While heating to 85°C, the nitrate content of the solution is adjusted to give an NO_3^-/ThO_2 mole ratio of 0.077 for the finished sol. A weighed batch (10 kg) of ThO_2 was flushed slowly into the tank with the correct amount of water to give a 2M ThO_2 sol. After digestion at 90°C with recirculation for 1 hr, sufficient NH_4OH was added to give a 0.017 NH_4OH/ThO_2 mole ratio. The nitrate adjustment ensures complete dispersion, and the NH_4OH adjustment fixes uranium on the surface of the thoria. This optimized procedure gives sols that lead to homogeneous oxide products whose particles vary in U/Th weight ratio by less than 1%. The oxides from these sols likewise consistently have particles of maximum density (9.9+ g/cc), and are easily packed to densities of 9.0 g/cc in fuel rods. The adjusted sol was pumped to the top of a series of sol-dryer trays arranged in cascade and connected by overflow tubes so that the sol, containing 10 to 15 kg of oxide, was distributed equally among them. The sol was dried to gel at 85 to 90°C in a stream of heated air. In 48 hr of drying time, gel particles ranging in size from 1 cm down to about 100 U. S. mesh size (about 90% of particles larger than 16 mesh) were produced, and they had 4 to 6% volatile matter and a density of 6 to 7 g/cc. Laboratory experiments indicated that particle size may be controlled by specifying conditions of sol-drying. Gels were calcined in air at a relatively slow rate of increase in temperature (100°C/hr) up to 500°C, and then at 300°C/hr up to 1150°C. After 1 hr in air, the atmosphere was changed to noncombustible 4% H_2–Ar and calcination continued at 1150°C for 4 hr. The furnace and charge were cooled under argon to about 200°C before being removed from the furnace. Laboratory experiments showed that calcinations and cooldowns conducted entirely in argon or nitrogen produced oxide products that had a density of as high as 9.9+ g/cc, an O/U ratio of 2.0500 or less, and a residual gas content of 0.005 cc/g or less, comparable with the results of calcinations in 4% H_2–Ar. However, in a larger furnace, where the atmospheres and the temperatures were cycled, good results were not achieved with inert gases because good control of atmosphere in contact with the charge was impossible. In testing calcined oxides to determine the quantities and species of gases contained in them, they were heated to 1200°C in vacuum. These quantities and species of gases were shown to depend on the furnace atmospheres used during the calcination and cooling steps, on size of the oxide particles, and on blanket gases in contact with the oxide during comminution to obtain optimum particle size distribution. The evolution of hydrogen and carbon monoxide were strongly indicated to be due to a reaction between carbon in the oxide and the water adsorbed during grinding. Water and carbon dioxide were the major gases released from oxides in which the O/U ratios were high. The bulk of water and carbon dioxide adsorbed by the oxide during grinding was evolved in vacuum at temperatures below 400°C. (auth)

1725 (ORNL-3488(p.42-54)) RADIATION CHEMISTRY. (Oak Ridge National Lab., Tenn.).

Ozone yields in the radiolysis of oxygen-nitrogen solutions at 77°K were observed by alternate gamma irradiation and absorption spectrophotometry. When aqueous silver nitrate solutions were exposed to Co^{60} gamma rays, Po^{210} alpha particles, or 2537-A light, the silver ions were reduced to silver metal. Electron micrographs revealed that the metal crystal forms vary with the linear energy transfer of the incident radiations. The suppressive action of the reducible solute NO_3^- on the $G(H_2)$ was followed as a function of pH to determine the nature of the reducing species formed by the action of Co^{60} gamma rays

on aqueous solutions. The suppression of the $G(H_2)$ was observed to be independent of pH, indicating that the major reducing species was the same at pH = 1 and 12.6. The $G(H_2)$ at 0 NO_3^- concentration, as determined by extrapolation of the experimental data, is about 5% greater at pH = 1 than at pH = 4.5 and 12.6. Higher $G(H_2)$ are consistent with the acid form, H atoms, having a slower reaction rate with NO_3^- than solvated electrons. Some results from the radiolysis of dilute arsenite solutions are given. The G values for arsenate formation and hydrogen peroxide consumption in deaerated solutions are given for neutral and 0.4 M sulfuric acid solutions. A comparison was made of the yields, and the effect of postirradiation annealing on these yields, for the decomposition of sodium chlorate by gamma rays and by alpha particles. The results are consistent with the previous postulate that thermal effects in alpha-particle tracks are a significant factor in the radiolysis. The radiolytic decomposition of the anhydrous alkaline earth bromates by Co^{60} gamma rays was found to increase with the atomic number of the cation from magnesium to barium. Initial radiolytic yields for bromate decomposition, $G_0(-BrO_3^-)$, were 1.75, 2.05, 2.79, and 3.02 molecules per 100 ev for $Mg(BrO_3)_2$, $Ca(BrO_3)_2$, $Sr(BrO_3)_2$, and $Ba(BrO_3)_2$, respectively. The alpha radiolysis of a stoichiometric mixture of H_2 and O_2 admixed with CO_2 indicated: CO_2 did not react chemically in this system; about 60% of the energy absorbed by the CO_2 was utilized in promoting the synthesis of water. A new kinetic expression was derived which is in good agreement with the experimental data. Manometric and gas-chromatographic studies of the radiation-induced surface oxidation of hydrocarbons were continued and extended. Equations describing the kinetics of the postirradiation catalytic reaction were derived. (auth)

1726 (RRL-106) THE GAS-PHASE RADIOLYSIS OF ETHYL CHLORIDE. Ralph N. Schindler (Mellon Inst. Radiation Research Labs., Pittsburgh). Mar. 18, 1963. Contract AT(30-1)-2310. 26p.

Ethyl chloride was bombarded with 2.8 Mev electrons in the gas phase. The main radicals produced in the primary chemical event are monochloroethyl and ethyl with the corresponding fragments. Their major reactions during radiolysis are given. The rate constant was determined to be 1.92 ± 0.2. Disproportionation reactions of chloroethyl radicals were found negligible. In addition, ethylene, acetylene, vinyl chloride, and hydrogen, in part, are formed by molecular elimination reactions. The molecular processes account for roughly half of all primary reactions observed. (P.C.H.)

1727 (RTD-TDR-63-4133) THE ROLE OF IONS IN THE RADIOLYSIS OF ORGANIC LIQUIDS. A. H. Samuel, M. A. Golub, and J. Danon (Stanford Research Inst., Menlo Park, Calif.). Nov. 1, 1963. Contract AF33(657)-8205. 53p.

Irradiation to 3×10^{21} ev/g of solutions of stannic chloride ($SnCl_4$) in toluene at 195°K by 1-Mev electrons gave o- and m- and/or p-chlorotoluene yields (G, molecules/100 ev) which were unaffected by changes in temperature and dose and by the presence of ethylene and nitric oxide, but rose with $SnCl_4$ concentration to approach a limiting total value near 0.2. When ethylene was present, G(total C_9H_{12}) was near 0.01. When CCl_4 was substituted for $SnCl_4$, a different product pattern was found. Squalene was irradiated with Co^{60} γ rays at room temperature and with 1-Mev electrons at 243°K. The main radiation-induced effects, with their G-values at room temperature, are loss of unsaturation (4.6), crosslinking (1.35), trans-cis isomerization (0.83), and hydrogen evolution (0.58). Most of the loss of unsaturation is attributed to cyclization; it occurs only in the crosslinked fraction. Increased yields (on the basis of energy absorbed in the solute) were trans-polyisoprene when these were irradiated in benzene solution. The chlorination of toluene and the cyclization of cross-linked squalene are believed to have ionic intermediates. (auth)

1728 (TID-19650) CARBON ISOTOPE EFFECTS IN THE PYROLYTIC DECOMPOSITION OF MANGANOUS OXALATE. Peter E. Yankwich and Petros D. Zavitsanos (Illinois. Univ., Urbana. Noyes Lab. of Chemistry). [1963]. Contract [AT(11-1)-1142]. 52p. (SM-50/26)

The C^{13} isotope effects, stoichiometry, and kinetics of the pyrolytic decomposition of anhydrous manganous oxalate were studied as a function of temperature. The principal reaction is $MnC_2O_4 = MnO + CO_2 + CO$, but $(CO_2/CO) = 1.04 \pm 0.03$ between 314° and 600°. At the start, the amount of reaction varies as t^m, m = 1.2 to 1.4; after the first 7% decomposition, the kinetics can be represented by a first-order rate law or an expression close to it. Regardless of the representation of the kinetics, an activation energy of ca. 44 kcal/mole and a pre-exponential factor near 10^{11} are associated with the appropriate rate constant. Between 280 and 510°, the intramolecular isotope effect observed at complete reaction falls from 0.80% to 0.35%, and is the same whether sodium oxalate or oxalic acid was used in the original precipitation. Samples prepared with sodium oxalate exhibit intramolecular and intermolecular isotope effects for 0 to 2% and 2 to 4% reaction which are consistent with those found upon complete pyrolysis. Samples precipitated with oxalic acid exhibit enormous isotope effects (e.g., 3:40% at 240°) in the partial decomposition experiments; these anomalous effects have huge temperature coefficients and disappear rapidly as the degree of reaction increases. Several theoretical approximations are employed to gain information about the reaction coordinate; calculations with simplified models can replicate the normal isotope effects. No detailed model is available for the abnormal isotope effects. (auth)

1729 (TID-19663) SOME EFFECTS OF GAMMA RAYS AND HELIUM IONS ON BIPHENYL. M. A. Sweeney (California Research Corp., San Francisco). June 30, 1963). Contract AT(04-3)-248. 36p.

Purified biphenyl was irradiated under vacuum with cobalt-60 gamma rays and with 48-Mev helium ions. Absorbed doses were in the range 10^{21} to 10^{22} ev g^{-1}. The products were separated and analyzed. Product yields from cobalt-60 irradiations at 82°C were $G_{H_2} = 6.5 \times 10^{-3}$, $G_{C_6H_6} = 0.47 \times 10^{-3}$, and $G\text{"}_{polymer}\text{"} = 0.2 \times 10^{-3}$. For helium ion irradiations at 82°C, $G_{H_2} = 18.5 \times 10^{-3}$, $G_{C_6H_6} = 2.8 \times 10^{-3}$, and $G\text{"}_{polymer}\text{"} = 0.3$. Increase of temperature caused much higher gas yields from gamma irradiations and somewhat higher yields from helium ion irradiations. The gas yields did not exhibit clear-cut dose dependence, but the formation of high-boiling products appeared to increase with dose. Unsaturated cyclic products were detected and were shown to undergo radiation-induced polymerization. (auth)

1730 (TID-19668) THE EFFECT OF HIGH ENERGY RADIATION ON THE CRYSTAL GROWTH RATE. Annual Report. Edward A. Mason, Robert C. Reid, and Gregory D. Botsaris (Massachusetts Inst. of Tech., Cambridge). Nov. 1963. Contract AT(30-1)-2909. 64p.

Initial experiments on the effect of gamma ray radiation on the rate of growth of potassium chloride crystals from supersaturated solutions were made. In these preliminary experiments, crystals grown in the presence of gamma rays in a Co^{60} source had a greater rate of growth than crystals

grown in the absence of radiation. The relative rates of growth of the three faces of the crystals also appeared to be altered by radiation. The effect of gamma rays on the density of potassium chloride crystals grown from solutions was studied. Such crystals grown in a Co^{60} radiation field were found to have a lower density than those grown in the absence of radiation. This phenomenon is believed to be due to the development of an irregular crystal structure which contains pockets of solution within the crystal. Methods of etching and polishing crystals of potassium chloride were studied as a future aid in determining the possible relationship between the number of lattice defects and any changes in crystal growth characteristics caused by radiation. The effect of gamma ray radiation on the nucleation characteristics of succinic acid crystals was studied. Radiation was found to decrease the degree of supersaturation required to cause nucleation of both pure aqueous solutions of succinic acid and of solutions containing a surface active agent. (auth)

1731 (TID-19671) RADICAL-MOLECULE COMPLEXES AS INTERMEDIATES IN LOW-TEMPERATURE RADIATION CHEMISTRY. Final Report. Philip L. Levins and Philip M. Sliney (Little (Arthur D.) Inc., Cambridge, Mass.). Nov. 1, 1963. Contract AT(30-1)-2977. 32p.

An experimental program was designed to test the hypothesis that radical-molecule complexes, possessing either an increased reactivity or an increased selectivity, could be formed at low temperature under the influence of ionizing radiation. The nitrosation of cyclohexane and 2,3-dimethylbutane with nitrosyl chloride in the presence of π-bonded solvents was investigated. The influence of metal carbonyls on the reaction between olefins and carbon monoxide was determined. A research program was initiated to study the solvent effect in radiation chemistry in terms of energy transfer. (auth)

1732 (CEA-tr-A-1378) UTILISATION DES RAYONNEMENTS IONISANTS EN CHIMIE EXPÉRIMENTALE ET INDUSTRIELLE (I ET II). (Utilization of Ionizing Radiation in Experimental and Industrial Chemistry. I and II). H. Mohler. Translated into French from Chemiker-Ztg., 84: 4, 107-12; No. 6, 175-9(1960). 49p.

The properties of ionizing radiation that made it of use in experimental and industrial chemistry are reviewed. The radiation units, dosimetry, and radiation sources are discussed. The effects caused by the passage of γ rays and electrons through matter and the theory of cluster formation are described. Calculations of the energy balance with the formation of radicals are illustrated. In the second part the chemical effects of radiation are compared and contrasted with the effects of catalysts, with the radiochemical preparation of high polymers, γ-hexachlorocyclohexane, hydrazine, hydrocyanic acid, and sulfuric acid given as examples. The effect of radiation on solid catalysts is briefly indicated. (J.S.R.)

1733 DETERMINATION OF THE QUANTITY OF FREE RADICALS FORMED ON THE RADIOLYSIS OF WATER, WITH THE AID OF A STABLE FREE RADICAL. G. V. Putyrskaya and I. Matush. Acta Chim. Acad. Sci. Hung., 38: 249-59(1963). (In Russian)

The direct quantitative determination of the radicals formed by the radiolysis of water is described, using stable free radical p,p'-disulpho-α,α-diphenyl-β-picrylhydrazyl(SDPPH) as a scavenger. The velocity of disappearance of SDPPH was examined depending on the dose rate, initial concentration, and other factors. The G-value was found to be 9.88 mol/100 ev in the case of critical concentration of SDPPH from which $G_{(-H_2O)}$ was calculated 5 mol/100 ev. The kinetics of the radiolysis is described, too. (auth)

1734 EMULSION POLYMERIZATION OF VINYL MONOMERS UNDER THE INFLUENCE OF IONIZING RADIATION. D. Hummel (Universitat, Cologne). Angew. Chem., Intern. Ed. Engl., 2: 295-308(June 1963).

The kinetics of emulsion polymerization induced by β, γ, and x radiation are discussed. Such ionizing radiations induce the polymerization of some vinyl monomers in aqueous emulsion with high radiation yields, and with identical emulsion compositions, the kinetics of this reaction and the kinetics of emulsion polymerization induced by water-soluble initiators are very similar. The rate of reaction in emulsion polymerization is ~100 times greater than in bulk polymerization. The initiation of emulsion polymerization by means of ionizing radiation permits uniform illumination of the reacting volume, as well as almost any desired variation in the frequency of initiation during the reaction. The sharp decrease in the overall rate of reaction when initiation is interrupted during emulsion polymerization of styrene induced by γ rays contradicts the earlier concept of sharply separated reaction zones. In addition to examination of the radiation initiated polymerization of styrene, that of methylmethacrylate, ethylacrylate, and vinyl acetate are discussed. Studies made on emulsion polymerization of methylmethacrylate initiated by γ rays showed that the overall rate of reaction for emulsion polymerization induced was 100-200 times larger than that in bulk polymerization induced by γ radiation. An overall rate of reaction of about 11%/min was calculated for a high dose rate from the value measured at the low dose rate. The conversion curve shows that after a steep rise in the overall rate of reaction during the period of particle formation, there follows a short period of zero reaction order. The curve then rises further and attains a max at about 50% conversion. Shortly thereafter it drops sharply, following neither first nor second order kinetics with respect to the monomer concentration in the particles. Ultimately, the high viscosity in the particles at high conversions hinders diffusion in the monomer; at the same time, the polymerization in the aqueous phase has sunk to a very small value, causing a steep decline in the overall rate of reaction. Emulsion polymerization of ethylacrylate at 25°C induced by γ rays at a dose rate of 2×10^{14} ev/g/min and a monomer:water ratio of about 1:7 gave an average molecular wt of the polymer at the end of polymerization of $\sim 1.6 \times 10^6$. A plot of the logarithm of the overall rate of reaction vs the reaction time reaches a max 6.5 min after the start of the reaction and then, without undergoing a period of zero order, falls slowly according to first-order kinetics relative to the monomer concentration. Beyond about 70% conversion, the decline becomes slower. Determination of reaction constants in emulsion polymerization induced by γ radiation is discussed. (BBB)

1735 LIQUID SCINTILLATION COUNTING OF C^{14}-LABELED AMINO ACIDS ON PAPER, USING TRINITROBENZENE-1-SULFONIC ACID, AND AN IMPROVED COMBUSTION APPARATUS. Claude F. Baxter and Ilse Senoner (City of Hope Medical Center, Duarte, Calif.). Atomlight, No. 33: 1-8(Nov. 1963).

The sodium salt of trinitrobenzene-1-sulfonic acid was used to detect C^{14}-labeled amino acid spots on paper without removing radioactivity from the carboxyl group. Combustion of the paper spots was carried out in improved combustion vessels with recoveries of radioactivity from

96 to 100%. The techniques were used to compare the effect of chromatography and electrophoresis upon the recovery of radioactivity in labeled amino acids. (auth)

1736 SECONDARY REACTIONS IN X-IRRADIATED LYSINE. Eckart Hussmann (Max-Planck-Institut für Biophysik, Frankfurt am Main). Biophysik, 1: 87-95(1963). (In German)

Secondary reactions on x-irradiated aqueous lysine solutions were investigated. These occurred only when O was present during the irradiation. The modification of the extinction of the irradiated lysine solution with time was followed in a uv spectrophotometer. With suitable variation of the temperature, the irradiation product concentration, buffering, and the pH value, it was concluded that at least two secondary reactions are present. These reactions are of the second order and are probably subject to a general acid-base catalysis. The contribution of keto acids to the reactions was evaluated from the modification of the spectrum during the secondary reactions. The occurrence of a decarboxylation reaction was shown by measurements with a Warburg apparatus. (tr-auth)

1737 REACTION KINETIC INVESTIGATION ON A RADIATION CHEMICAL SYSTEM WITH CONTINUOUS AND PULSE MODULATED X RADIATION. [PART] I. A. P. Lotz and K. Schmidt (Max-Planck-Institut für Biophysik, Frankfurt am Main). Biophysik, 1: 96-107(1963). (In German)

Studies with pulse-modulated ionizing radiation permit the lifetime of short-lived intermediate products in radiation reactions to be determined. For the evaluation of these "time constants" of irreversible radiation reactions, the frequency-effect curve can be used. This curve is obtained when the effects summed over many pulse periods, at constant mean dose output and irradiation time, were considered as a function of the pulse frequency. In the present study, the hydrochloric acid formation of aqueous chloral hydrate solutions under x radiation was investigated. In addition to the dose output dependency of the HCl formation velocity at continuous irradiation, the frequency-effect curve was discussed. The results of the continuous irradiation study can be described under the assumption that the formation of the HCl molecule results from a chain reaction in which both bimolecular and monomolecular quenching reactions take place. This was confirmed by studies at various temperatures. Comparison with the results of other authors yields a quantitatively satisfactory agreement. The behavior of the chemical system under pulse irradiation was simulated with an electrical analog circuit, and the frequency-effect curve was represented in a normalized generally applicable form. The comparison of this curve with the frequency-effect curve of the chloral hydrate system permits the determination of the lifetime of the reaction chain. (tr-auth)

1738 PREPARATION OF PALLADIUM-109, GALLIUM-72 AND CHROMIUM-51 IN A HIGH SPECIFIC ACTIVITY. Hiroshi Ebihara (Japan Atomic Energy Research Inst., Tokyo). Bunseki Kagaku, 11: 341-6(Mar. 1962). (In Japanese)

The preparation of some radioisotopes in a high specific activity was studied utilizing the Szilard-Chalmers effects of some metal oxinates (8-hydroxyquinolinates). The experimental results obtained for palladium, gallium, and chromium oxinates are given. Dehydrated oxinates were irradiated and dissolved in an organic solvent. The organic solution of oxinates was shaken with Michaelis' buffer solutions of various pH values. Comparing radioactivities of both layers, the extractability was calculated. On the other hand, the amount of metals coming into the aqueous phase was determined. Based upon those values each enrichment factor was calculated. The experiments of separation with palladium showed that about 23% activity was found in the aqueous solution at pH 4 after shaking with the organic solution, whereas the oxinate was kept in the organic phase. The experimental data for gallium showed that about 45% activity was found in the aqueous phase of 1N sodium hydroxide solution. Chromium(III) oxinate was kept in the chloroform layer when it was shaken with the aqueous solution of pH 6 to 8. So the hot atom-separation of chromium (III) will be expected at the same pH range. Aniline and chloroform were used for the solvent of chromium oxinate. The extractabilities from each solution were 18 to 19% for the chloroform and about 8% for the aniline. They were scarcely varied at the pH range 6 to 8. (P.C.H.)

1739 A RAPID SEPARATION OF FISSION PRODUCTS BY PAPER ELECTROPHORESIS. Shoichi Kawamura (National Inst. of Radiological Sciences, Tokyo). Bunseki Kagaku, 11: 814-18(Aug. 1962). (In Japanese)

A rapid separation of Cs^{137}, Sr^{90}, Ce^{144}, and Zr^{95} by paper electrophoresis was studied. The filter strips were placed in a background electrolyte. After removal from the solution, they were blotted between sheets of dry paper. The strips were sandwiched by plastics plate and cooling bath, and screwed tightly. They were allowed to equilibrate for 30 minutes. The sample solution (0.005 ml) containing Cs^{137}, Sr^{90}, Ce^{144}, and Zr^{95} was spotted at a point 10 cm apart from one end of the filter strip through a hole of plastics plate, and then the hole was covered with cellophane tape. The most suitable conditions for the separation were investigated in detail, using tartaric acid, citric acid, acetic acid and formic acid. Separation of trace Cs^{137}, Sr^{90}, Ce^{144} and Zr^{95} from each other was carried out in only 25 minutes using 0.05M ammonium citrate, pH 3.5, as the electrolyte at 1080 v, and the mixture of those with 0.05M carrier of each was separated in only 20 minutes at 1440 v. (auth)

1740 FREE RADICALS INDUCED BY γ RADIATION IN DESOXYRIBONUCLEIC ACID: EFFECT OF THE MOLECULAR WEIGHT. Albert Van de Vorst and Jules Duchesne (Université, Liège). Compt. Rend., 257: 1877-80(Sept. 16, 1963). (In French)

An electron paramagnetic resonance study showed how the free radical yield induced by Co^{60} γ radiation depends on the molecular weight in the case of desoxyribonucleic acid in the solid phase. Some possible biological consequences of the effect obtained, especially with respect to the frequency of mutations, are examined. (tr-auth)

1741 ACTION OF ULTRAVIOLET RADIATION ON UREASE. Bernard Magnan de Bornier and Nicole Bensaid-Desmidt (Faculté de Médecine, Montpellier, France). Compt. Rend., 257: 1881-3(Sept. 16, 1962). (In French)

The exposure of aqueous solutions of urease to ultraviolet radiations causes a transitory increase of the urease activity and a decrease of the Michaelis constant from 1.72 to 0.94. Interpretation of this fact is delicate as the uv radiation acts on the proteins in the denaturing agent. It seems that, in the first irradiation period, the urease molecule assumes a more active structure than the initial structure. This can be due to the liberation, following the unfolding of the polypeptide chains of the urease molecule, of reaction sites normally masked inside the enzyme. (tr-auth)

1742 ABSOLUTE STANDARDIZATION WITH A NaI(Tl) CRYSTAL. II. DETERMINATION OF THE TOTAL EFFICIENCY. G. A. Brinkman, A. H. W. Aten, Jr., and

J. Th. Beenboer (Inst. for Nuclear Physics Research, Amsterdam). Intern. J. Appl. Radiation Isotopes, 14: 433-7(Oct. 1963).

The absolute standardization of radioisotopes emitting two γ rays of about equal energy in coincidence (e.g., Sc^{46}, Co^{60}, pure β^+ emitters) is possible with a NaI(Tl) well-type crystal by measuring the total count-rate inside and outside the well. (auth)

1743 THE PREPARATION AND PROCESSING OF RADIOACTIVE GASES FOR CLINICAL USE. P. D. Buckingham and G. R. Forse (Hammersmith Hospital, London). Intern. J. Appl. Radiation Isotopes, 14: 439-45(Oct. 1963).

Radioactive oxygen, carbon monoxide and carbon dioxide produced in the Medical Research Council cyclotron were used for several years for the investigation of pulmonary and cardiac malfunction. The development of the system for the processing of these gases, from a simple laboratory arrangement, to a semi-automatic remotely controlled plant for regular clinical use is described. (auth)

1744 THE MECHANISM OF THE RADIATION CHEMICAL DEGRADATION OF AMINO ACIDS. III. RADIOLYSIS OF NORVALINE IN AQUEOUS OXYGENATED AND OXYGEN-FREE SOLUTIONS. J. Kopoldová, J. Liebster, and A. Babický (Czechoslovak Academy of Science, Prague). Intern. J. Appl. Radiation Isotopes, 14: 455-60(Oct. 1963).

A study was undertaken with norvaline with the purpose of studying the effect of chain length on the degradation mechanism in oxygenated and oxygen-free solutions. (auth)

1745 YIELD OF HYDROGEN IN LOW-TEMPERATURE POLYETHYLENE RADIOLYSIS. G. K. Vasil'ev, V. E. Skurat, and V. L. Tal'roze (Inst. of Chemical Physics, Academy of Sciences, USSR). Izv. Akad. Nauk SSSR, Ser. Khim., No. 10, 1871-3(Oct. 1963). (In Russian)

Kinetics of H_2 and D_2 formation in radiolysis of high-density polyethylene and deutero-polyethylene at ~20 and 90°K was studied. Radiation yields, $G(H_2)$ and $G(D_2)$, decrease with increased radiolysis. The drop in $G(H_2)$ and $G(D_2)$ at ~90°K is not related to the reaction $H + R \rightarrow RH$, where H is a hydrogen atom and R is a stabilized radical. (R.V.J.)

1746 THE RADIOLYSIS OF METHANOL AND METHANOLIC SOLUTIONS. II. COMPARISON OF RADIOLYSIS BY Co^{60} γ-RAYS AND BY $B^{10}(n,\alpha)Li^7$ RECOILS. Masashi Imamura, Sang Up Choi, and Norman N. Lichtin (Boston Univ.). J. Am. Chem. Soc., 85: 3565-70(Nov. 20, 1963).

At recoil dose rates in the vicinity of 4.5×10^{15} ev ml^{-1} min^{-1} $G(H_2) = 4.99 \pm 0.36$, $G(CH_4) = 0.57 \pm 0.14$ $G(CO) = 1.00 \pm 0.13$, $G(CH_2O) = 3.15 \pm 0.38$, $G(C_2H_6O_2) = 0.60 \pm 0.09$, independent of dose over the range $(0.44-10.8) \times 10^{19}$ ev ml^{-1} and of dose rate over the range $(0.33-25) \times 10^{15}$ ev ml^{-1} min^{-1}. All yields are insensitive to added KI up to 0.1 M. The effects of change in LET by a factor of 10^3 are rationalized tentatively on the basis that there is little variation in initial relative abundance of primary radical and molecular products but that reactions of higher than first order in primary radicals are of increased importance. Satisfactory reproducibility in the Co^{60} γ radiolysis of pure methanol was not obtained. Alkali fluorides, chlorides, and bromides all reduce $G(H_2)$ but have no significant effects on other yields. Alkali iodides also reduce $G(H_2)$ from Co^{60} γ radiolysis and, in addition, decrease $G(C_2H_6O_2)$ and increase $G(CH_2O)$ by equal amounts without significant formation of iodine. This observation can be rationalized by the coupled reduction of CH_3O and oxidation of CH_2OH by I^- and I, respectively. (auth)

1747 EFFECTS OF MILLIMOLAR CONCENTRATIONS OF SILVER(I) ION UPON THE γ-RADIOLYSIS OF CRYSTALLINE POTASSIUM NITRATE. Joseph Cunningham (Argonne National Lab., Ill.). J. Am. Chem. Soc., 85: 3716-18(Nov. 20, 1963).

The kinetics of formation of equivalent nitrite, $M(NO_2^-)$, were determined in pure and in silver-doped KNO_3, prepared by cocrystallizing mixtures of $AgNO_3$ and KNO_3, containing 0.04, 0.10, 0.4, and 1.0 mole % of Ag^+. Two mechanisms that could account for the observed efficiency of millimolar concentrations of Ag^+ in reducing initial radiolysis are discussed. (P.C.H.)

1748 RADIOCHEMICAL POLYMERIZATION OF STYRENE AT LOW TEMPERATURE IN THE PRESENCE OF BROMATED SOLVENTS. Adolphe Chapiro and Yoshizo Tsuda (C.N.R.S., Bellevue, France). J. Chim. Phys., 60: 1021-8(Sept. 1963). (In French)

The radiochemical polymerization of styrene in ethyl bromide solution at -78° was studied by using high intensity radiation (45-kv x rays and γ rays from a 10,000-C Co^{60} source). In the presence of air, the reaction has an induction period that is followed by great acceleration. This acceleration is interpreted by a supplementary polymerization started by the bromine released by the radiolysis. Under vacuum, the conversion curves are linear and the reaction is strongly inhibited by water. Experiments on the copolymerization of styrene with methyl methacrylate have shown that at the intensities used the reaction proceeds principally by a cation mechanism with, however, a slight contribution of a radical mechanism. The addition of bromoform to the ethyl bromide accelerates the polymerization. Some tests were also made by dissolving styrene in mixtures of bromobenzene or carbon tetrabromide with ethyl bromide and toluene. (tr-auth)

1749 STUDY OF THE PROPERTIES OF SOME GRAFT COPOLYMERS. I. PREPARATION OF SAMPLES. STUDY OF SOLUBILITY AND SWELLING. Adolphe Chapiro and Anna-Maria Jendrychowska-Bonamour (C.N.R.S., Bellevue, France). J. Chim. Phys., 60: 1029-37(Sept. 1963). (In French)

Graft copolymers having incompatible constituents were prepared radiochemically. A study of their properties has led to the following results. The solubility of the polystyrene–polyacrylonitrile graft copolymer in solvent–precipitant media depends on the character of the precipitant used. By grouping the character of the precipitants according to the value of internal energy density δ, it is seen that in the case of precipitants having δ greater than that of polyacrylonitrile, the graft copolymers are more soluble than the two constituent homopolymers. When the value of δ of the precipitant is between that of the two constituent polymers, the solubility of the graft copolymers is intermediate between that of the two homopolymers. If the value of δ of the precipitant is much smaller than the δ of the polystyrene, the graft copolymers containing 34 and 58% polystyrene are less soluble than the two constituent homopolymers. The copolymer containing 88% polystyrene has the same solubility as polystyrene. Swelling of the polyethylene–polyacrylonitrile in xylene at 50° has a maximum for the copolymer containing 7% acrylonitrile. This effect seems due to a decrease of the crystallinity of the polyethylene during grafting, which results in an easier penetration of the copolymer by the solvent. At 100°, pure polyethylene is completely soluble in xylene. Grafting of acrylonitrile progressively decreases this solubility. (tr-auth)

1750 STUDY OF THE PROPERTIES OF SOME GRAFT COPOLYMERS. II. STUDY OF THE THERMOMECHANICAL PROPERTIES, OF THE MODULUS OF ELASTICITY, AND OF THE DEFORMABILITY. Anna-Maria Jendrychowska-Bonamour (C.N.R.S., Bellevue, France). J. Chim. Phys., 60: 1038-43(Sept. 1963). (In French)

Study of the thermomechanical properties of polyethylene–polyacrylonitrile and polystyrene–polyacrylonitrile graft copolymers shows that all the copolymers have the same temperature of vitreous transition (T_g), that of the constituent having the lowest T_g. Low grafting of acrylonitrile on polyethylene or polystyrene is sufficient to prevent the sample reaching the viscous flow state. The results of the study of the mechanical properties at different temperatures have shown that grafting of styrene on teflon decreases its deformability at low temperatures, whereas a region of high elasticity appears at temperatures higher than the T_g of polystyrene. Microscopic examination of teflon–polystyrene grafted copolymers exposed to a thermal treatment at 300° shows rearrangement of the copolymer structure. (tr-auth)

1751 KINETIC STUDIES OF THE PHOTOCHEMICAL REDUCTION OF URANYL SULFATE IN THE PRESENCE OF ALPHA-HYDROXYISOBUTYRIC ACID. [PART] I. Kuan Pan and Wen-kuei Wong (National Taiwan Univ., Taipai, China). J. Chinese Chem. Soc. (Taiwan), 8: 1-13 (May 1961).

The photochemical reduction of U(VI) to U(IV) sulfate in the presence of α-hydroxyisobutyric acid, accompanied by the decarboxylation and oxidation of the acid to acetone, was observed. The reaction rate was found to be fourth order, or pseudo first-order with respect to the U(VI) ion concentration in an excess of the acid by following spectrophotometrically the concentration of U(IV) ion produced. A fourth-order rate equation has been derived. The specific rate constants, k and k′, for the fourth-order and pseudo first-order reactions gave the mean values, k = 3.4 and k′ = 5.2. The technique and apparatus used to prepare uranous sulfate for calibration by electrolysis of uranyl sulfate are described. Two pieces of platinum wire gauze were used as cathode and anode, and a sintered glass as diaphragm in a pyrex glass cell surrounded by a water jacket through which a current of steam was passing. (BBB)

1752 SZILARD-CHALMERS REACTION WITH COPPER CHELATES. Si-jung Yeh, Moon-lung Yin, and Jing-liang Chou (National Tsing Hua Univ., Hsinchu, Taiwan). J. Chinese Chem. Soc. (Taiwan), 9: 205-19(Dec. 1962).

Four Cu compounds (bis-acetylacetone-Cu(II) (A), bis-dibenzoylmethane-Cu(II) (B), acetylacetoneethylenediimine-Cu(II) (C), and benzoylacetoneethylenediimine-Cu(II) (D)) were prepared. They were used as the targets for carrying out the Szilard-Chalmers process to investigate the feasibility for the enrichment of Cu^{64}. Both solvent extraction and reprecipitation methods were used to separate the enriched Cu^{64}. No enrichment was brought about in the operations with compounds A and B under the condition studied; with compounds C and D however, enrichment factors of the order of 200-400 and 70-90, respectively, were observed. To prepare C, the most effective compound, the method of McCarthy et al., with slight modifications, was used. Three g (0.05 mole) ethylenediamine was added slowly to 10 g (0.1 mole) acetylacetone to form straw-colored solid acetylacetoneethylenediamine. The solid was dissolved in water and heated to 60-70°C, and 6N ammonium hydroxide was added until the solution was alkaline to phenolphthalein. The red precipitate, formed when a warm solution of 0.05 mole of cupric acetate in 100 ml water was added, was purified by reprecipitation from acetone by adding water. This compound was very soluble in the common organic solvents but insoluble in water. In extractions the irradiated target was dissolved in chloroform to make a 1% target solution. When appropriate portions of the target solution of C were extracted with equal volumes of acetate buffers with various pH values, the enrichment factor increased rapidly from 50 to 400 as the pH of the extractant increases from 3 to 6. In the region of pH 6-10, the enrichment factor decreased slowly from 400 to 250. When enrichment factor was studied as a function of the concentration of ammonium hydroxide solution, it increased abruptly from 150 to 290 as the concentration increased from 0.01 to 0.5N. It decreased slowly from 290 to 170, when the concentration of ammonium hydroxide is further increased from 0.5 to 15N. In an attempt to improve the efficiency of enrichment of Cu^{64} by the extraction method, the effect of electrolytes on the extraction process was investigated. When target solutions were extracted with equal volumes of 0.1N solutions, salts were found to be much better extractants than weak acids or weak bases. For separation of enriched Cu^{64} the reprecipitation method was very much inferior to the extraction methods. The reason for the failure of A and B may be attributed to the rapid thermal exchange reaction between ruptured Cu^{64} and inactive Cu atoms in the target compound. It was concluded that the O–O chelates of Cu are not suitable for the enrichment of Cu^{64} by Szilard-Chalmers process, but that N–O chelates appear promising targets. N–N chelates also give high enrichment factors (up to 420). (BBB)

1753 THERMAL NEUTRON CAPTURE IN GASEOUS AND LIQUID PHOSPHINES. II. NON-VOLATILE PRODUCTS, PRIMARY RETENTION AND SCAVENGER EFFECTS. M. Halmann and L. Kugel (Weizmann Inst. of Science, Rehovoth, Israel). J. Inorg. Nucl. Chem., 25: 1343-50(Nov. 1963).

P^{32}-labeled products from thermal neutron capture in gaseous and liquid trimethylphosphine were determined, using gas and paper chromatography and paper electrophoresis. Inclusion of substances that might act as radical scavengers had no effect on product yields. The amount of primary retention of P^{32} in trimethylphosphine was found to be of the same order of magnitude as predicted by the random walk theory. The yields of labeled compounds increase in the series trimethyl-, dimethyl-, methyl-, and inorganic P^{32}-products. The yields of di- and trimethylphosphine after neutron capture in gaseous trimethylphosphine are less than predicted by simple statistical considerations, while higher yields than predicted are obtained from liquid trimethylphosphine. (auth)

1754 EFFECTS OF HIGH ENERGY RADIATION ON POLYMERS. Sebastian Kalarickal and M. Prakasa Reddy. J. Madras Univ., 32B: 277-422(Aug.-Dec. 1962).

A review is presented on the effects of high energy radiation on polymers. 175 references are included. (P.C.H.)

1755 THE THEORY OF ELECTRON SCATTERING FROM MOLECULES. II. MOLECULAR HYDROGEN. R. A. Bonham and T. Iijima (Indiana Univ., Bloomington). J. Phys. Chem., 67: 2266-72(Nov. 1963).

Expressions for the differential cross sections for the total electron scattering (including all inelastic processes) and the elastic electron scattering from molecular hydrogen were derived. The total molecular intensity was computed with both the Wang and Weinbaum molecular wave

functions and the effect of the chemical bond on the calculations is discussed. The binding effects should contribute only small corrections to the usual interpretation of diffraction results for the case of H_2 unless extremely small angle scattering data were available. (auth)

1756 SOME ASPECTS OF THE RADIATION CHEMISTRY OF METHANE. L. W. Sieck and R. H. Johnsen (Florida State Univ., Tallahassee). J. Phys. Chem. 67: 2281-8(Nov. 1963).

In order to establish the relative chemical importance of initial ionization and excitation processes in the high energy radiolysis of methane, discharge tube studies under various conditions were correlated with high energy electron bombardments using chemical and spectroscopic techniques. The studies indicate an overwhelming chemically interesting contribution from processes initiated by ionization. Investigations of the radiolysis at very low conversions indicate a dose-dependence for the yields of hydrogen and ethane that can be related to ethylene production and subsequent consumption by free radical attack. In addition, the process for polymeric liquid formation was investigated. A general interpretation was attempted, particularly with regard to the role of hydrogen atom abstraction processes. (auth)

1757 IONIC AND FREE RADICAL PROCESSES IN LIQUID MIXTURES CONTAINING HYDROCARBONS. John Roberts and William H. Hamill (Univ. of Notre Dame, Ind.). J. Phys. Chem., 67: 2446-50(Nov. 1963).

Yields of HCl from γ irradiation of cyclo-C_6H_{12} solutions containing CCl_4, $CHFCl_2$, $CFCl_3$, CF_2Cl_2, $C_4F_4Cl_2$, and C_2H_5Cl were measured over a range of concentration. $G(H_2)$ for cyclo-C_6H_{12}–cyclo-C_6H_{10} with 0.03 M I_2, $G(CH_4)$ for n-butane–cyclo-C_6H_{12}, and both $G(H_2)$ and $G(CH_4)$ for n-C_6H_{14}–CH_3I were also examined, all at ca 20°C. Mixtures of C_2H_5I in 80% alkane–20% alkene and also in methyltetrahydrofuran were irradiated at −196°C and analyzed subsequent to thawing for $G(H_4)$, $G(C_2H_4)$, and $G(C_2H_6)$. All results are considered in relation to ionic processes in irradiated organic glasses. (auth)

1758 ELECTRON-BEAM INITIATED POLYMERIZATION OF AN ORGANIC VAPOR ADSORBED ON A METAL SURFACE. P. White (Standard Telecommunication Labs., Ltd., Harlow, Essex, Eng.). J. Phys. Chem., 67: 2493-4(Nov. 1963).

The formation of an initial polymer layer by radiation treatment of monomer vapors adsorbed or condensed onto a metal surface is discussed. It is suggested that the first step in the polymer formation must be polymerization of the gas already adsorbed on the metal surface, subsequent layers being formed by adsorption of further gas prior to polymerization. It was concluded that the monomer molecules adsorbed on a metal surface are in an energy state from which they can very easily enter into a chain reaction and form polymer molecules containing initially up to 30 monomer units. The initial layer must then form the base from which the polymer film grows. (P.C.H.)

1759 A REVALUATION OF THE QUANTUM EFFICIENCY OF THE URANYL OXALATE SYSTEM. C. A. Discher, P. F. Smith, I. Lippman, and R. Turse (Rutgers Univ., Newark, N. J.). J. Phys. Chem., 67: 2501(Nov. 1963).

The quantum efficiencies of uranyl oxalate solutions are tabulated. At 365.5 mμ, the values have a range of 0.483 to 0.497, with a mean of 0.492 and a standard deviation of the mean of 0.002. At 435.8 mμ, the mean value of the results is 0.573, with a standard deviation of the mean of 0.002. The results compare with previously reported values. (P.C.H.)

1760 FORMATION OF RADICALS IN RADIOLYSIS OF SOLID ORGANIC SUBSTANCES. II. YIELD OF RADICALS IN BENZENE AND DIPHENYL DERIVATIVES. Yu. N. Molin, I. I. Chkheidze, E. P. Kaplan, N. Ya. Buben, and V. V. Voevodskii (Inst. of Chemical Physics and Inst. of Organic Chemistry, Academy of Sciences, USSR). Kinetika i Kataliz, 4: 557-60(July-Aug. 1963). (In Russian)

Electron paramagnetic resonance was used for measuring radiation yields from benzene and biphenyl derivatives. It was found that in the investigated compounds the G_R is 1.5 to 3 times higher than in benzene ($G_B = 0.2$) and considerably smaller than $G_{add} = \gamma_A G_A + \gamma_D G_D$, where γ_A, γ_D, and G_A and G_D are electron fractions and yields of aromatic (A) and saturated (D) groups. Energy transmission from substituent to aromatic groups was evaluated on the basis of the data. For most compounds the energy transmission coefficient is near unity. (tr-auth)

1761 ON THE TEMPERATURE LIMITING OF THE EFFECTS OF RADIATION ON THE RATE OF CHEMICAL PROCESSES. A. M. Brodskii and K. P. Lavrovskii (Inst. of Oil Chemistry, USSR). Kinetika i Kataliz, 4: 652-3 (July-Aug. 1963). (In Russian)

An analysis was made of conditions under which the effects of temperature on radiation-induced chemical decomposition is negligible (though the temperature is not so high as to disturb the thermodynamic balance) and the decomposition of organic compounds follows a normal course, even if the heating is the result of irradiation. The experiment was carried out in order to verify the postulate that radiation-thermal decomposition of oil fractions offers a better product than the one produced by thermal cracking. (R.V.J.)

1762 DEGRADATION BY GAMMA IRRADIATION OF THYMUS DEOXYRIBONUCLEOHISTONE IN SOLUTION. P. H. Lloyd and A. R. Peacocke (Oxford Univ.). Nature, 200: 428-9(Nov. 2, 1963).

Aqueous solutions of DNH (about 4×10^{-4} g/ml) in 0.7 mM phosphate buffer (pH 6.8) were subjected, without exclusion of oxygen, to 1–1.3 Mev gamma rays from a Co^{60} source. The initial effect of the radiation on DNH in solution was to dissociate the histone, with at first little or no denaturation of the DNA. The proposal that the initial degradation of DNH is a one-hit process is now further supported, and sedimentation investigations indicated that all the DNH molecules, whatever their initial size, were dissociated by irradiation to the same extent. (P.C.H.)

1763 RADIOLYSIS OF GASEOUS HYDROGEN HALIDES. R. A. Lee and D. A. Armstrong (Univ. of Alberta, Calgary, Can.). Nature, 200: 552-3(Nov. 9, 1963).

The rate of hydrogen formation from hydrogen chloride in pyrex bulbs subjected to Co^{60} radiation was examined in the presence of chlorine and bromine in concentrations varying from 0 to 5 mole %. The effects observed were independent of bulb size, surface coating, and pressure of HCl. It was concluded that more than one hydrogen-forming species is involved in the gas phase radiolysis of HCl. Similar observations were made with HBr in the presence of of bromine and sulfur hexafluoride. (P.C.H.)

1764 RADIOACTIVE CATALYSTS. V. I. Spitzine. Nucleus (Paris), 4: 284-92(July-Aug. 1963). (In French)

The Soviet studies made since 1958 on the effect of radioisotopes on the properties of catalysts are critically reviewed. The effect of the radiation intensity, the specific radioactivity, and the absorbed dose is shown. The sub-

stitution of different radioisotopes modifies the catalyzed reactions in various ways. (J.S.R.)

1765 pH EFFECTS IN THE γ-RADIOLYSIS OF AQUEOUS SOLUTIONS. F. S. Dainton and W. S. Watt (Univ. of Leeds, Eng.). Proc. Roy. Soc. (London), Ser. A, 275: 447-64(Oct. 29, 1963).

From the effects of nitrous oxide on the radiation chemistry of aqueous solutions containing either acrylamide, or potassium ferrocyanide and ferricyanide, the following conclusions are drawn. G_{H_2} and $G_{H_2O_2}$ diminish only slightly as pH is increased from pH 0 to 13.5. At $4.5 \leq pH < 12$, $G_{e^-} = 2.8$ and $G_{HO} = 2.3$, but as the pH is increased to 13.5 both these quantities increase by about 1 unit, an effect that is attributed to the reaction of OH^- with either radical pairs (H + OH) or excited water molecules H_2O^*, i.e., (H + OH) or $H_2O^* + OH \rightarrow e^-_{aq.} + OH$. Solutes are divisible into three categories according as they react with $e^-_{aq.}$ only, or quench H_2O^*, or provide an alternative route for H + OH recombination, or react with $e^-_{aq.}$ and H atoms to give distinguishable stable products. $k(e^-_{aq.} + \text{ferricyanide})/k(e^-_{aq.} + N_2O) = 0.60 \pm 0.15$ at $\mu = 0.013$ but increases with μ in a way that indicates that $e^-_{aq.}$ has unit negative charge and survives long enough for the establishment of its ionic atmosphere. $k(e^-_{aq.} + H^+_{aq.})/k(e^-_{aq.} + N_2O) = 0.65 \pm 0.35$, $k(e^-_{aq.} + \text{acrylamide})/k(e^-_{aq.} + N_2O) = 1.2 \pm 0.2$ and $k(H + \text{ferricyanide})/k(H + N_2O) = 625 \pm 100$. (auth)

1766 THE $(CH_3)_2\dot{C}COOH$ RADICAL IN X-IRRADIATED α-HYDROXYISOBUTYRIC ACID. O. Franklin Griffith and Howard Shields (Wake Forest Coll., Winston-Salem, N. C.). Radiation Res., 20: 443-50(Nov. 1963).

Measurements were made of the anisotropy in the ESR spectra for a radical of the form $R\dot{C}(CH_3)_2$. A radical of this form is produced by x irradiation of a α-hydroxyisobutyric acid and identified with ESR. A basic seven-component ESR spectrum is observed, resulting from an equal interaction of the unpaired electron on the α-carbon with the six H nuclei of the methyl groups. The seven-component spectrum is split into doublets on the low-field side of the spectrum, owing to anisotropy in the hyperfine coupling constant and the g factor. The principal values of the coupling constant were found to be, in gauss, 21.7, 22.7, and 23. The orientations of the two radicals per unit cell were also determined with respect to a set of axes assigned to the crystal. (auth)

1767 FEASIBILITY OF A LIQUID-PHASE CHEMONUCLEAR OZONE PROCESS. J. P. Cagnetta, D. Goellner, and M. Steinberg (Brookhaven National Lab., Upton, N. Y.). Trans. Am. Nucl. Soc., 6: 315-16(Nov. 1963).

1768 RADIOLYSIS AND PROPERTIES OF SANTOWAX OMP AT ELEVATED TEMPERATURES. C. D. Sawyer, E. A. Mason, and W. N. Bley (Massachusetts Inst. of Tech., Cambridge). Trans. Am. Nucl. Soc., 6: 407-8(Nov. 1963).

1769 RAPID IDENTIFICATION OF RADIOACTIVE TRACERS IN SELECTED MATERIALS WITH LARGE-VOLUME LIQUID SCINTILLATION DETECTORS. E. D. Jordan (Catholic Univ. of America, Washington, D. C.). Trans. Am. Nucl. Soc., 6: 418(Nov. 1963).

1770 CALCULATION OF PRODUCTION AND PRICING OF TRANSURANIUM ISOTOPIC HEAT SOURCES. Duane E. Deonigi, E. T. Merrill, and A. F. McConiga (General Electric Co., Richland, Wash.). Trans. Am. Nucl. Soc., 6: 420-1(Nov. 1963).

1771 SOME REMARKS ON THE RADIOLYSIS OF LIQUID WATER. M. Magat (Faculté des Sciences, Orsay, France). Z. Physik. Chem. (Frankfurt) (N.F.), 38: 161-9 (Aug. 1963). (In French)

It appears possible to predict with very good approximation, because of energy reasons, the order of magnitude of the number of molecules of water initially decomposed by radiolysis. However, numerous points must be defined before it will be possible to predict, from these considerations, the yields of individual species and, in particular, the yields in molecular compounds. (tr-auth)

1772 RADIORESISTANCE OF POLYMERIZED ANION EXCHANGE RESINS. E. D. Kiseleva, K. V. Chmutov, and V. N. Krupnova (Inst. of Physical Chemistry, Academy of Sciences, USSR). Zh. Fiz. Khim., 37: 1626-9(July 1963). (In Russian)

Radiation effects on anion exchange resins (styrene with divinyl benzene and ion exchange groups AB-17, -27, and -18) in distilled water or nitric acid were investigated. It was found that ionized radiation by accelerated electrons with a dose of 0.05 to -0.7×10^{23} ev/g reduces the ion exchange volume and alters the absorption properties of AB-17 and AB-27 resins. A certain amount of ion exchange groups transferred into water or acid solutions. The radioresistance of AB-18 anion exchanger is higher than AB-17 and -27. Exposures to 2×10^{23} ev/g doses do not affect ion exchange properties of the examined ionite. (R.V.J.)

1773 FORMATION OF HYDRAZINE IN β IRRADIATION OF LIQUID AMMONIA AND AMMONIA AQUEOUS SOLUTIONS. Yu. A. Sorokin, V. I. Tsivenko, and S. Ya. Pshezhetskii (Karpov Research Inst. of Physics and Chemistry, USSR). Zh. Fiz. Khim., 37: 1871-5(Aug. 1963). (In Russian)

Gamma radiolysis of liquid ammonia was investigated and formation of N_2H_4, N_2, and H_2 as a function of dosage at various temperatures was determined. The yields of these substances were found at −70, −26, and 15°C. Hydrazine formation in irradiated ammonia aqueous solutions was investigated at a wide range of concentrations and the maximum of N_2H_4 formation as a function of solution composition was found. (R.V.J.)

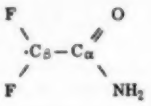
1774 GAMMA RADIATION EFFECTS ON FORMATION AND REACTIONS OF FREE RADICALS IN SOLID AMMONIA AND HYDRAZINE. V. I. Tupikov and S. Ya. Pshezhetskii (Karpov Research Inst. of Physics and Chemistry). Zh. Fiz. Khim., 37: 1900-3(Aug. 1963). (In Russian)

Reactions of NH_2 radicals with NH_3 molecules and recombination of NH_2 radicals as a result of γ irradiation of solid ammonia were studied using the method of electron paramagnetic resonance. The data indicated that the radical recombinations induced by γ rays are the result of migration of free valence electrons and hydrogen atoms. The mechanism results in a maximum radical concentration. Effects of ultraviolet rays on recombination of NH_2 and N_2H_3 radicals in solid ammonium and hydrazine were investigated. It was found that ultraviolet-induced reaction between OH radical and NH_3 at liquid hydrogen temperature formed NH_2 and HO_2 radicals. (R.V.J.)

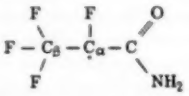
1775 FLUORINE HYPERFINE INTERACTION IN THE ESR OF IRRADIATED ORGANIC SINGLE CRYSTALS. Robert Lontz and Walter Gordy (Duke Univ., Durham, N.C.). p.795-804 of "Paramagnetic Resonance. Vol. II." New York, Academic Press, 1963.

Single crystals of CF_3CONH_2 and of $CF_3CF_2CONH_2$ were

γ-irradiated and the induced ESR patterns observed and analyzed. The results show that the stable free radical



is produced in CF_3CONH_2. Analysis of the F^{19} hyperfine structure indicates that this radical, except for the H atoms, is planar. Although the structure of the crystal is unknown, the planes of the radicals are found to have two orientations 68° apart, both parallel to crystal faces. The F^{19} couplings of the two F atoms are equivalent and are anisotropic, with principal values of $A_1 = A_2 = 24$ and $A_3 = 178$ gauss. Its axial symmetry indicates that the coupling arises primarily from electron spin density in an F orbital which has an axis of symmetry perpendicular to the plane of the radical. The stable free radical found in irradiated $CF_3CF_2CONH_2$ is



The F^{19} coupling of the CF group is similar to that found in the CF_2CONH_2 radical, but the coupling in the CF_3 group is different and arises partly through hyperconjugation interaction with the σ bonds and partly through π bonding to the F atoms. Surprisingly, at room temperature the F's of the CF_3 group have equivalent coupling, a fact which seems to indicate that the CF_3 group is rotating. The ESR of the irradiated $CF_3CF_2CONH_2$ decays rapidly in air, whereas that of irradiated CF_3CONH_2 does not. (auth)

1776 ENVIRONMENTAL EFFECTS IN RADIATION CHEMISTRY OF ORGANIC SUBSTANCES. Milton Burton (Univ. of Notre Dame, Ind.). Strahlentherapie, Sonderbaende, 51: 1-18(1962). (In English)

Environmental effects may be divided into those which are common to chemical effects on organic systems in general and those which are peculiar to radiation chemistry. While the former are by no means trivial and must be considered in the detailed kinetic and mechanistic analysis of the radiation chemistry of organic substances, they involve no new concepts. Environmental effects that are the consequences of details of excitation of the system in radiation chemistry, the geometrical distribution of such excitation, the possible excited states which may be obtained, the states which are actually involved in chemical processes, and the methods of dissipation of excitation including the conveyance of energy from the site of initial excitation to the site of initial chemical effect are reviewed. By no means are all of these details adequately known, but there is some theory and some experimental evidence that indicate that environmental effects in radiation chemistry are distinctly different from the environmental effects of the more orthodox branches of chemistry. Some of these effects are discussed in detail. Factors principally considered are excitation transfer and its consequences as interpreted both from straightforward radiation chemistry of mixtures and from studies of luminescence phenomena. Present theories concerning distinctive direct and indirect effects are discussed. Chemical processes in irradiated cyclohexane-benzene mixtures, in which deuterated analogs of the hydrocarbons were used as tracers, in various environments are cited as an example. (C.H.)

1777 CHEMICAL MECHANISMS OF SOME AGENTS WHICH MODIFY BIOLOGICAL RADIATION RESPONSE. Michael Ebert (Medical Research Council, Hammersmith Hospital, London). Strahlentherapie, Sonderbaende, 51: 19-27(1962). (In English)

The effects of O_2, NO, and CO_2 on radioinduced chemical and biological changes are discussed. Results are reported from observations on the effects of various gas treatments on the electron spin resonance in an irradiated organic macromolecule, in which polymethylmethacrylate (Perspex) was used as the test material. The three gases were shown to enter into radiation chemical reactions with organic molecules in the solid and liquid phase. It was concluded that explanations of the effects of O_2 and NO in biological radiation experiments reasonably agree with the radiation chemical reactions observed. Experimental evidence indicated that CO_2 increases radiosensitivity in wet biological systems only in the presence of O_2. Possible reactions involving CO_2 are discussed. (C.H.)

1778 THE DETECTION OF RADIATION-FORMED H_2O_2 BY ENZYMES AND THEIR DEPENDENCE ON MILIEU FACTORS. Hugo Aebi (Universität, Bern). Strahlentherapie, Sonderbaende, 51: 28-45(1962). (In German)

Enzymes can be used in neutral aqueous solutions for H_2O_2 detection. Some of the enzymes show a sufficient radiation resistance, besides the great number of alterations and high substrate specificity, to be inserted for this purpose with good chance for success. For continuous combination of the H_2O_2 formed in irradiated solutions, enzymes in pure substances, together with a suitable substrate, are added to the mixture as an indicator before irradiation. Effects of radiation dose, enzyme concentration, and type of enzyme are discussed. The system catalase and C^{14}-labeled formate were irradiated and results are presented. (M.C.G.)

1779 RADIATION-CURED CASTABLE ELASTOMERS. [PART] I. POLYURETHANES. M. A. Klotz, J. P. Kispersky, L. T. Carleton, and E. Mishuck (Aerojet-General Corp., Azusa, Calif.). 14p. (CONF-117-17)

From American Chemical Society 145th National Meeting, New York, Sept. 1963.

Elastomeric polyurethane castings were prepared by Co^{60} irradiation of liquid unsaturated polyurethanes, which were prepared from fifteen unsaturated diols, two diisocyanates, and two polymeric saturated diols. At 1.2×10^5 rad/hr, vinyl co-monomers were required to achieve crosslinking. Methyl acrylate, vinyl acetate, and acrylonitrile, covering a wide range of Alfrey-Price Q values, were used in screening tests, to increase the probability of obtaining a crosslinked product with any of the unsaturated diols. All gave crosslinked polymers but acrylonitrile was best. Ethylene diacrylate, ethylene dimethacrylate, ethylene dichloride, and ethylene dimercaptoacetate were also effective crosslinking agents. At 7.5×10^5 rad/hr, no co-monomer was required. The best elastomers were produced from tolylene diisocyanate, polypropylene glycol, and glyceryl monolinoleate. The tensile strength, the crosslink density, and G (crosslinking), were roughly inversely proportional to the concentration of unsaturated diol. The G values indicate that the efficiency of the reaction increased as the concentration of the crosslinking agent decreased. G (crosslinking) ranged from 64 to 145, consistent with a vinyl polymerization mechanism of short chain length. The crosslink yield, moles of crosslinks per mole of unsaturated diol, ranged from 0.24 to 1.37; the latter figure suggests that both double bonds of the linoleate chain entered into the reaction. (auth)

1780 RADIATION-CURED CASTABLE ELASTOMERS. [PART] II. POLYTHIOETHERS. M. A. Klotz, J. P. Kispersky, L. T. Carleton, C. W. Saltonstall, R. E. Phillips, V. Grakauskas, and E. Mishuck (Aerojet-General Corp., Azusa, Calif.). 10p. (CONF-117-17)

From American Chemical Society 145th National Meeting, New York, Sept. 1963.

Strong elastomers were prepared by the reaction of long chain dithiols with long-chain diolefins, using triolefins or long-chain trithiols as crosslinking agents. Free-radical initiators gave erratic behavior, and ultraviolet irradiation could not be used because of opacity, but γ-radiation from a Co^{60} source gave excellent results. Swelling ratios, sol fractions, and tensile strengths were measured as a function of radiation dose. The reaction of a diolefin with a dithiol was found to follow second-order kinetics, with an initial G value for the formation of thioether bonds of 4560 per 100 ev. The G value decreases with increasing extents of reaction. When the reaction is 95% complete, G (thioether bonds) is of the same order of magnitude as –G(C-H), so that decomposition becomes a competing reaction. (auth)

1781 EXCITATION OF HYDROCARBONS BY LOW-ENERGY ELECTRON IMPACT. C. R. Bowman and W. D. Miller (General Dynamics/Fort Worth. Div. of General Dynamics Corp., Fort Worth, Tex.). 21p. (CONF-250-11; FZM-3042).

From American Physical Society 1963 Summer Meeting in the West, Edmonton, Can., Aug. 1963.

Excitation curves for the saturated paraffin hydrocarbons CH_4, C_2H_6, and C_3H_8 are measured for incident electron energies in the range 0 to 15 ev, utilizing a trapped electron technique with an incident energy uncertainty of ±0.1 ev. Gas samples are flowed through the apparatus at pressures of 10^{-4} to 10^{-2} mm Hg to minimize filament contamination. A single maximum occurs in CH_4, with onset at 7.5 ev and a broad peak at 11.8 ev preceding ionization onset. Single broad maxima are indicated for C_2H_6 and C_3H_8 with similar onsets at 6.5 ev. Negative ion formation does not appear to be a factor in electron interaction with these gases. (auth)

1782 RADIATION EFFECTS IN POLYVINYL ACETATE. L. D. Maxim (Syracuse Univ., N. Y.); R. H. Marchessault, V. T. Stannett, and C. H. Kuist. 16p. (CONF-117-13).

From American Chemical Society 145th National Meeting, New York, Sept. 1963.

Studies are made of the variations in molecular weight, soluble fraction, network swelling, and other parameters of polyvinyl acetate as a function of radiation exposure, in order to determine whether polyvinyl acetate degrades, crosslinks, or both degrades and crosslinks upon high-energy irradiation. It is found that degradation and/or crosslinking can occur, depending on the irradiation conditions. (T.F.H.)

1783 TREATMENT OF COTTON WITH RADIATION POLYMERIZED ACRYLONITRILE. Jett C. Arthur, Jr., and Robert J. Demint (to U. S. Dept. of Agriculture). U. S. Patent 3,109,798. Nov. 5, 1963. Filed Apr. 8, 1960.

A process is given for treating cotton to decrease the stiffness and increase the elongation-at-break of the cotton fibers without significantly changing the other properties. The process comprises immersing the cotton in an aqueous solution of acrylonitrile monomer, irradiating the cotton with at least 800,000 r, extracting the extraneous polymer by dimethyl formamide or dimethyl sulfoxide, and finally washing and drying the fibers. Since the solubility of acrylonitrile in water is limited, a salt such as $ZnCl_2$ can be added to the solution to increase the solubility. (D.L.C.)

1784 IRRADIATIVE HYDROXYLATION OF BENZENIC HYDROCARBONS IN THE AQUEOUS PHASE. Roger Montarnal and Jacques Prévé (to Institut Francais du Petrole, des Carburants et Lubrifiants and Commissariat à l'Énergie Atomique). U. S. Patent 3,110,653. Nov. 12, 1963. Priority date May 28, 1959, France.

A process is given for the radiolytic hydroxylation of benzenic hydrocarbons in aqueous, oxygenated solutions with improved yield. The process comprises adding to the solutions a small amount of a metal oxide or sulfide in dispersed form, the additive being ZnO, ZnS, NiO, ThO_2, CuO, Co_2O_3, TiO_2, or ZrO_2 in the form of grains less than 50 μ thick. Several examples of the process are given using benzene and toluene. (D.L.C.)

Separation Processes and Procedures

Refer also to abstract 3387.

1785 (CEA-2237) ÉTUDE DE L'ARRÊT DE L'IODE PAR LES CHARBONS ACTIFS. (Study of the Trapping of Iodine by Active Charcoals). J. Pradel, G. Chevalier, and F. Billard (France. Commissariat à l'Énergie Atomique. Centre d'Études Nucléaires, Saclay). 1962. 40p.

The efficiency of active charcoal towards I^{131} was studied during a series of experiments. The influence of: the iodine concentration of the air current, the rate of flow of air across the charcoal, and the charcoal thickness, was determined. The results obtained lead to the conclusion that the iodine, after passage across a so-called "absolute" filter, is present in two different physical forms, and that the action of the active charcoals is different for the two forms. These results make it possible, however, to calculate industrial filters with a good degree of approximation. (auth)

1786 (CEA-2322) RECHERCHE DE DEPOTS DE SELS DE PLUTONIUM DANS LES BATTERIES D'EXTRACTION DU PLUTONIUM DE L'USINE DE MARCOULE. (Search for Plutonium Salt Deposits in the Plutonium Extraction Batteries of the Marcoule Plant). Henry Bouzigues and Jean-Marie Reneaud (France. Commissariat à l'Énergie Atomique. Centre de Production de Plutonium de Marcoule, Chusclan). 1963. 21p.

A method and a special apparatus are described which make it possible to detach the insoluble plutonium salt deposits in the extraction chain of an irradiated fuel treatment plant. The process chosen allows the detection, in the extraction batteries or in the highly active chemical engineering equipment, of plutonium quantities of a few grams. After four years operation it has been impossible to detect measurable quantities of plutonium in any part of the extraction chain. The results have been confirmed by visual examinations carried out with a specially constructed endoscope. (auth)

1787 (IDO-16925(p.131-46)) COMMERCIAL RECOVERY OF URANIUM SCRAP—A PROGRAM REVIEW. E. L. Keller (Oak Ridge Operations Office, AEC).

The experience of the Oak Ridge Operations Office during FY 1963 in administering the AEC's uranium scrap reprocessing contracts with industry is reviewed with respect to industrial participation, contract development

and changes, contractor performance, shipper-receiver differences, recovery costs, and packaging and shipping problems. (auth)

1788 (IDO-16925(p.147-59)) PROCEDURES FOR TRANSFER OF IRRADIATED ENRICHED URANIUM TO THE IDAHO CHEMICAL PROCESSING PLANT. J. W. Pollock (Idaho Operations Office, AEC).

The Idaho Chemical Processing Plant was designated by the Atomic Energy Commission as its site to receive irradiated reactor fuel elements containing highly enriched uranium. Depending upon the availability of suitable processing equipment at the ICPP, the fuel is either processed or stored until it can be processed. A brief description is given of the fuel receiving and fuel processing facilities. The operational and administrative procedures for sending irradiated material to the ICPP are discussed. (auth)

1789 (IDO-16925(p.160-72)) APPORTIONMENT TO PARTICIPANTS OF TOTAL RESIDUAL U-235 AS DETERMINED FROM CHEMICAL PROCESSING MEASUREMENTS IN AN INTEGRATED PROCESSING RUN. F. H. Tingey and L. B. Hansen (Phillips Petroleum Co., Idaho Falls, Idaho).

Pooling fuel from several reactors for chemical processing is discussed. Methods for determining how the total residual U^{235}, as chemically measured during processing, can be prorated to the individual participants and for determining the associated bias are proposed. Examples using these methods are included. (M.C.G.)

1790 (IEA-61) KINETICS OF URANIUM(IV) ELUTION FROM CATIONIC EXCHANGE RESIN. AMMONIUM SULPHATE AS ELUENT. Almir Augusto Laranja (Brazil. Instituto de Energia Atomica, Sao Paulo). Sept. 1963. 13p.

The kinetics of uranium(VI) elution using ammonium sulfate from a cation exchanger resin are described. Results on the concentration of uranyl in the solid phase a function of time are shown. These allow the conclusion that a second-order reaction takes place, according to the equation: $-dC/dt = KC^2$. The values of rate constants, in several concentrations of ammonium sulfate were found and plotted as a function of the composition of eluent. The equilibrium conditions and the effects of the mass of resin-volume of eluent were also studied. (auth)

1791 (KR-56) INVESTIGATION OF THE EXTRACTION CHROMATOGRAPHY OF Am(VI) AND Bk(IV). E. K. Hulet (Norway. Institutt for Atomenergi, Kjeller). Oct. 1963. 13p.

The extraction of Am(VI) and Bk(IV) tracers has been investigated by reversed-phase partition chromatography in a continuing effort to improve the separation of normally trivalent transplutonides. Simultaneous elution of Am(VI) and Cm(III) tracers from 0.20 M bis(2-ethylhexyl) orthophosphoric acid (HDEHP) absorbed in a stationary bed of silica resulted in 90 to 92% Am extraction. A decontamination factor (DF) from Cm of 1000 was obtained. Non-extractable Cm(III) was quantitatively eluted giving a DF of 10 to 14 from Am. Attempts by the same method to extract anionic americyl sulphate complexes with triisooctyl amine failed, though the existence of such complexes was demonstrated by adsorption in anion exchange resin. By extraction chromatography Bk(IV) was totally extracted into 0.2 to 1.0 M HDEHP (n-heptane) and retained in the column bed. Quantitative reduction to Bk(III) and elution occurred with 9 M $HNO_3 + H_2O_2$. (auth)

1792 (MCW-1481) METHODS FOR TAPPING MOLTEN URANIUM FROM AN ELECTROLYTIC CELL. R. D. Piper, J. D. Vie, J. N. Reyland, R. J. Kornfeld, and D. E. Treadway (Mallinckrodt Chemical Works. Uranium Div., Weldon Spring, Mo.). Nov. 15, 1963. Contract W-14-108-eng-8. 17p.

Methods of tapping molten U from an electrolytic cell in which it is formed and transferring the molten metal to ingot molds have been tested in the laboratory and pilot plant. Two methods appear suitable: a stopper rod and weir system using a UO_2-impregnated graphite stopper rod, and a vacuum-withdrawal system using a heated graphite pipe to carry the molten U to an evacuated mold chamber. The vacuum-withdrawal system is superior and will be used in a prototype electrolytic cell. (auth)

1793 (NP-13269) INACTIVE STORAGE. Technical Report No. 128. P. Fischer (European Company for the Chemical Processing of Irradiated Fuels, Mol., Belgium). Nov. 28, 1961. 25p. (ETR-128)

Details are given of the installations necessary for the liquid, solid, and gas stores, and of the measures which need to be taken to comply with safety regulations. Specifications of the storage tanks and pumps, and plans showing the proposed lay-outs for the tanks, pumps and solid storage, are included, together with a cost estimate for the equipment required. (auth)

1794 (NP-13270) DISSOLUTION, IN THE RECIRCULATION DISSOLVER, OF ALUMINIUM BY SODIUM HYDROXIDE. J. Van Caeneghem and Y. Marchant (European Company for the Chemical Processing of Irradiated Fuels, Mol, Belgium). June 1962. 21p. (ETR-133)

The study of aluminum dissolution in the laboratory recirculation dissolver includes a comparison of different procedures for the dissolver equipment. The stability of sodium hydroxide/sodium aluminate solutions has been studied, and a basic flowsheet for aluminum de-cladding in the recirculation dissolver is proposed. (auth)

1795 (NP-13272) THE BEHAVIOR OF NITRIC ACID AND URANIUM IN THE EUROCHEMIC EXTRACTION FLOWSHEETS FOR UNENRICHED FUEL: MIXER-SETTLER RUNS ON EUROCHEMIC FLOWSHEET NO. 3. E. Lopez-Menchero, W. Drent, and G. Magni (European Company for the Chemical Processing of Irradiated Fuels, Mol, Belgium). Jan. 3, 1962. 92p. (ETR-137)

Presented are the data obtained for nitric acid and uranium in minimixer-settler runs for the different cycles of Eurochemic flowsheet no. 3. Included in all cases are: 1) An initial study of the established cycle with a theoretical McCabe-Thiele diagram for uranium, leading to the suitable placing of the inlet position of the streams entering the battery, 2) the composition of uranium and nitric in both phases for each settler after steady state conditions were reached (from these data the uranium losses in the effluents and solvent saturation can be obtained), 3) a compilation of the experimental data on McCabe-Thiele diagrams, and 4) the efficiency of the real extraction stages, enabling subsequent comparisons to be made with the data obtained from pulsed columns. (auth)

1796 (NP-13283) MONTHLY REPORT [OF] DEVELOPMENT, SEPTEMBER 1963. (Eldorado Mining and Refining Ltd. Research and Development Div., Ottawa). 6p.

Methods for separating germanium from Taiga carbonaceous shale by flotation and salt roasting are described. The recovery of vanadium from Beaverlodge mill tailings by carbonate leaching is briefly discussed. Methods of chemical analysis are also discussed. (N.W.R.)

1797 (NYO-10038) FISSION PRODUCT SEPARATION BY FOAM EXTRACTION. Jacques J. Weinstock, Sarah Mook, Ernest Schonfeld, Eliezer Rubin, and Robert Sanford (Radiation Applications Inc., Long Island City, N. Y.). June 24, 1963. Contracts AT(30-1)-2384 and AT(30-1)-2093, Subcontract 2024. 123p.

A study was made of the applicability of the principles of foam separation to the enrichment and recovery of specific fission product nuclides from typical nuclear waste solutions. A review of foam separation principles is given and the experimental methods and equipment used are described. Investigation of equilibrium included studies of the characteristics of the experimental apparatus (e.g., time required to reach equilibrium), the effects of metal ion concentration and foaming agent concentration on interfacial adsorption equilibrium, and the effect of the choice of foaming agent on the potential degree of separation attainable. Screening of commercial foaming agents established specific foaming agents and types of agents which are effective in the removal of cesium, strontium, and cerium ions from aqueous solution. Each surfactant was tested for solubility, foamability, and enrichment at three different pH values, and for the critical micelle concentration (CMC). Out of 107 surfactants tested, 73 gave a reasonably good foam at one or more pH values and were tested for metal ion enrichment. Twenty were found promising in cesium removal, 33 in strontium removal, and 10 in cerium removal. Generally, only the anionic type surfactants were found effective, and each one of the three metal ions was found to be best separated within a specific pH range. Also included in this evaluation of specific reagents was the study of several combinations of materials which resulted in promising separations of cesium from solution. Studies were made of multistage foam separation column variables. Among these variables are the effects of: reflux, foam column height, expanded column head for drainage, splitting foaming agent feed between column top and bottom, and countercurrent foam washing. A detailed discussion and evaluation of the experimental results relative to the chemical separation of radioisotopes is given. This discussion of foam separation applicability includes an account of the current status of foam separation technology and a summary of the effects of pH, of the concentrations of various ionic species and foaming agents, and of physical operating variables. A wide range of approximate process operating costs is given ($0.40 to $3.00 per 1000 gallons of feed solution), but it is concluded that current foam separation technology does not allow the preparation of reliable flowsheets or cost estimates for a foam separation isotope recovery plant. (auth)

1798 (ORNL-3385) STATUS AND PROGRESS REPORT FOR THORIUM FUEL CYCLE DEVELOPMENT FOR PERIOD ENDING DECEMBER 31, 1962. D. E. Ferguson, comp. (Oak Ridge National Lab., Tenn.). Oct. 28, 1963. Contract W-7405-eng-26. 143p.

Progress is reported on the thorium fuel cycle development under two topics: sol-gel process development and fabrication and material development. Separate abstracts were prepared for the two topics. (M.C.G.)

For abstracts of individual items see: 1724 and 2204.

1799 (ORNL-3496) CHEMICAL TECHNOLOGY DIVISION, CHEMICAL DEVELOPMENT SECTION C, PROGRESS REPORT ON SEPARATIONS CHEMISTRY AND SEPARATIONS PROGRESS RESEARCH FOR JANUARY–JUNE 1963. K. B. Brown (Oak Ridge National Lab., Tenn.). Oct. 25, 1963. Contract W-7405-eng-26. 116p.

Cesium Recovery from Ores. Adaptation of the phenol extraction (Phenex) process to the recovery of cesium from ore leach liquors continued to show promise. In roast-leach tests, 98 to 99% of the cesium was dissolved from pollucite ore by roasting the ore at 800°C with 1.8 parts of Na_2CO_3 plus 1.2 parts of NaCl and leaching with water. More than 99% of the cesium was recovered from the leach liquor and separated from other alkali metals by extracting with 4-sec-butyl-2-(α-methylbenzyl)phenol (BAMBP) in diisopropylbenzene and stripping with hydrochloric acid. Santophen-1 also extracted cesium effectively, but, because of the limited solubility of the cesium-Santophen-1 complex in the diluent, the utility of this phenol in ore processing is questionable. Separation of Alkali Metals. The extraction and separation of alkali metals from nitrate solutions was studied with several different types of extractants, including substituted phenols, alkylphosphoric acids, sulfonic acids, carboxylic acids, and mixtures of some of these. With all of these reagents, cesium was extracted more strongly than rubidium, which in turn was extracted more strongly than the other alkali metals. Separation factors were higher with the phenols than with the other extractants. Acid Recovery by Amine Extraction. Preliminary tests showed the potential usefulness of tertiary amines for recovering and purifying phosphoric acid from the highly contaminated wet-process acid produced in the fertilizer industry. Water stripping of the amine solvent yielded a product that was more than 1.5 M in H_2PO_4 and was almost free of iron and aluminum. Final-Cycle Plutonium Recovery by Amine Extraction. Batch equilibration tests with both aged and fresh samples of Purex-plant 1BP solution showed that the aged but not the fresh samples contained a considerable quantity of zirconium-niobium species highly extractable by the hydrocarbon diluents used with amines and other extractants. The amounts of zirconium-niobium extractable from the aged solution were sufficient to account for the low decontamination previously obtained when aged plant 1BP solution was used to continuous countercurrent testing of the plutonium-recovery flowsheets. Individual and batch cascade tests with the fresh plant solution showed separation and decontamination factors high enough for use in the projected process. Extraction of Lanthanides and Transplutoniums by Dialkylphosphoric Acids. The behavior of americium and curium relative to the lanthanides in extraction by di(2-ethylhexyl)phosphoric acid (HDEHP) from carboxylic acids was shifted from the behavior in extractions from mineral acids, where americium is similar to promethium. The shift was greatest in extractions from oxydiacetic acid, where cerium was 4 times as extractable as americium, while differences within the element groups were very small. Extractions from nitric acid were increased by adding glycine (aminoacetic acid). Extractions were greatly reduced by adding a phenol to HDEHP. Ditridecylphosphoric acid (HDTDP) was a stronger extractant than HDEHP and gave smaller differences between the lanthanides. Di(2-ethylhexyl)-di-thio-phosphoric acid was a much weaker extractant than HDEHP and gave only small differences between the elements. Extraction of Nitric Acid, Lanthanides, and Transplutonium Elements by Amines. A tertiary amine (Alamine 336) nitrate extracted nitric acid from 6 N $LiNO_3$ until the apparent composition was $R_3N \cdot 1.5\ HNO_3$. A quaternary ammonium (Aliquat 336) nitrate extracted nitric acid from 6 N $LiNO_3$ until the apparent composition was $R_4NNO_3 \cdot HNO_3$. Alamine 336 extracted europium and americium about 3 times as well as cerium from carboxylic acids, while preference was in the reverse order from concentrated

$Al(NO_3)_3$. Aliquat 336 extracted cerium, europium, and americium strongly and about equally from dilute $KHCO_3$ solutions. Extraction of Americium(VI). In several extraction systems Am(III) was more extractable than Am(VI). Maximum preference factors were higher than 10^4 for extraction by di(2-ethylhexyl)phosphoric acid, higher than 100 by tri-n-octylphosphine oxide, and about 30 by tributyl phosphate. In extractions by amines, the differences were smaller and under some conditions in the reverse direction. Some of the systems appear suitable for the separation of americium from curium. Separation of Transplutonium Elements from Iron. Separation of transplutonium elements from large amounts of iron may be possible by precipitation with fluoride. Very high separation of americium and iron was obtained by multistage countercurrent extraction of americium with di(2-ethylhexyl)phosphoric acid in diisopropylbenzene from dilute nitrate solutions containing 0.04 M citric acid at pH 4.5, followed by stripping with dilute nitric acid containing 0.04 N citric acid at pH 0.5. Extraction of Metals from Chloride Solutions with Amines. In further studies on the extraction of metal ions from HCl and LiCl–0.2 M HCl (0.5 to 10 M ΣCl^-) with representative primary, secondary, tertiary, and quaternary amines in diethylbenzene, maximum extraction coefficients obtained (0.1 M amine) were about 70 for Ge(IV), 70 for Se(IV), 6×10^{-4} for Rb, 4×10^{-3} for Sr, 0.03 for Y, 200 for Nb(V), and 1700 for Mo(VI). In general, extraction coefficients increased with increasing chloride concentration and were higher with Aliquat 336 (quaternary amine) than with the other amines. N,N-Dialkyl Amides as Extractants. Fourteen amides were tested for their ability to extract uranium and thorium, and several of them to extract zirconium, hafnium, europium, cerium, americium, and nitric acid, from aqueous solutions. The extractions varied widely with structure of the amides, suggesting that, with suitable choice of structure and aqueous nitric acid concentration, thorium and uranium can be recovered either separately or simultaneously. None of the amides gave uranium extraction as high as did tributyl phosphate (TBP), but all indicated uranium-thorium separations that were at least as good as those obtained with TBP. Calculated uranium-fission product separation factors with some branched amides were two- to tenfold better than those obtainable with TBP, and there was evidence that it may be possible to separate transplutonium elements from lanthanides. The amides along were ineffective extractants for uranium or thorium from sulfuric acid and hydrochloric acid solutions, but their combinations with di(2-ethylhexyl)-phosphoric acid gave synergistic uranium extraction about as high as that with di(2-ethylhexyl)phosphoric acid and TBP. The amides tested extracted nitric acid readily. A number of conditions were encountered where poor phase separations occurred. Phase separations were usually better when the amide was dissolved in an aromatic rather than an aliphatic diluent. Uranium stripping was accomplished by water or by dilute nitric acid. The stability of the amides to hydrolysis by acids increases with increasing molecular weight. After severe treatment with boiling 2M HNO_3, two high-molecular-weight amides showed 20 to 40% hydrolysis. Distribution Coefficients and Separation Factors as Functions of Diluent Type: Tributyl Phosphate–Aromatics vs Tributyl Phosphate–Aliphatics. Solutions of tributyl phosphate (TBP) in some simple alkylbenzenes, for example, diethylbenzene, butylbenzene, and trimethylbenzene, gave uranium extraction coefficients from 2 M HNO_3 which were about 1.5 times higher than those shown by the same concentration of TBP in Amsco 125-82. Calculated separation factors of uranium from hafnium were about 2 times higher. Improved Stability of Amsco 125-82. The stability of Amsco 125-82 (an aliphatic hydrocarbon) toward nitric acid was improved in two ways: (1) by treatment with concentrated sulfuric acid to destroy the sites otherwise reactive to nitric acid, probably by sulfonation to sulfuric acid-soluble by-products by or rearrangement of the molecule to a more stable configuration; and (2) by preliminary nitric acid degradation followed by scrubbing with sulfuric acid, in which the important nitration products are soluble. After treatment, the Amsco could be degraded with nitric acid but at a consistently low rate, very similar to that of the relatively stable n-dodecane. Diluent Effect on Strontium Extraction by Di(2-ethylhexyl)phosphoric Acid. With n-nonane as diluent, strontium extraction by di(2-ethylhexyl)-phosphoric acid (HDEHP) was synergized by the addition of tributyl phosphate and depressed by the addition of dodecyl alcohol. The maximum enhancement observed was a doubling, and it occurred when the mole ratio TBP/DEHP was near 2. With benzene and some other diluents, in contrast, the E_{Sr} remained nearly constant at each given value of the mole ratio NaDEHP/ΣDEHP. Both NaDEHP/ΣDEHP and E_{Sr} shifted vs pH with additives to benzene and with substitution of other diluents: to lower pH with benzene + TBP and with dibutyl ether; to higher pH with benzene + dodecyl alcohol and with chloroform. The Equilibria Between Tri-n-octylamine and Sulfuric Acid in Various Diluents of Low Volatility. A diluent of low volatility suitable for use with tri-n-octylamine (TOA) and its sulfate salts (TOAS and TOAHS) is desired in order to permit the determination of water activities in the extractant phase by isopiestic osmotic balancing. Several low-vapor-pressure liquids that showed sufficient miscibility with TOA and TOAS were tested as diluents in the equilibrium extraction of sulfuric acid. While their equilibrium curves differed noticeably from each other and from that obtained with benzene, they were sufficiently like the latter to be considered for tests to be compared with tests in benzene. Two of these, phenylcyclohexane (vapor pressure, 60 μ at 25°C) and n-hexadecane modified with 5 vol % dodecanol (vapor pressure of mixture, less than 5 μ) were chosen for first use in the projected isopiestic tests. (auth)

1800 (ORNL-3516) AMINES AS EXTRACTANTS—SURVEY OF THE DESCRIPTIVE AND FUNDAMENTAL EXTRACTION CHEMISTRY. C. F. Coleman (Oak Ridge National Lab., Tenn.). Nov. 26, 1963. Contract W-7405-eng-26. 39p.

Both the study and the use of extractions with high-molecular-weight amines (including quaternary ammoniums) in organic solution are increasing extensively. While equilibria have been measured in the extraction of an increasing range of acids and metal ions, a difficulty remains unresolved in that the amine concentration power-dependence of extraction often indicates a different stoichiometry of the complex existing in the organic phase than do limiting loading and other considerations. Nevertheless, amine extraction serves as a useful tool in studying complexes formed in aqueous systems. Process applications have progressed especially in nitrate and chloride systems, in addition to the sulfate systems first emphasized. Systematic surveys, together with information accruing from process development, have extended the ranges of extractions that can be correlated in usefully generalized patterns, which in turn should accelerate the development of

new applications. However, many more areas remain to be surveyed before the many pertinent variables will have been covered. New amines of all classes have become available at commercial, development, or research-sample levels, while a few previously promising amines have become less available. Descriptions and current sources are reviewed. (auth)

1801 (ORNL-TM-645) LABORATORY DEVELOPMENT OF A COMBINED CHLORIDE VOLATILITY-AQUEOUS PROCESSING METHOD FOR URANIUM–ZIRCONIUM NUCLEAR FUELS. T. A. Gens (Oak Ridge National Lab., Tenn.). Oct. 15, 1963. Contract W-7405-eng-26. 29p.

The operations in a process proposed for recovering uranium from spent uranium–zirconium alloy fuels, including collecting the volatilized chlorination products (mainly zirconium tetrachloride and uranium pentachloride) in boiling water, concentrating the resulting solution, lowering the freezing point by removing chloride with hydrogen peroxide, and recovering uranium from the 5 M Zr product solution by solvent extraction with tributyl phosphate in Amsco diluent, were investigated in the laboratory and appeared to be reducible to large-scale practice. The high temperature chlorination equipment would also be adaptable for burning graphite matrix fuels and when combined with Darex equipment for processing fuels containing stainless steel, molybdenum, or aluminum may provide the basis for a feasible universal fuel processing system. (auth)

1802 (TID-19708) ION EXCHANGE SEPARATION OF URANIUM AND THORIUM IN NON-AQUEOUS AND MIXED MEDIA. Progress Report No. 2, April–September 1963. Johann Korkisch (Vienna. Universitat). Contract AT(30-1)-2623. 62p.

The anion exchange behavior of hexavalent uranium and a number of other elements in organic solvents containing organic acids is described. Based on the results of these investigations, several separation methods for uranium from other elements were developed. Studies as to the applicability of di- and tricarboxylic acids for the purpose of separating the elements uranium, thorium, and the rare earths on an anion exchange resin were also carried out. As a result, a method for the separation of uranium from thorium and the rare earths was found. (auth)

1803 (CEA-tr-X-175) ETUDE SUR LA MÉTHODE D'EXTRACTION EMPLOYANT DES ISOTOPES RADIOACTIFS. SÉPARATION MUTUELLE DE ^{90}Sr ET ^{90}Y PAR L'EMPLOI D'UNE SOLUTION BÉNZENIQUE DE TTA. (Study of Extraction Method Used for Radioisotopes. Mutual Separation of Sr^{90} and Y^{90} by Use of a Solution of Benzene and TTA). N. Suzuki and Kato. Translated into French from Nippon Kagaku Zasshi, 80: 1148-51 (1959). 17p. (Includes original, 4p.).

With the purpose of separating in a simple manner Sr^{90} and Y^{90} of high purity and with high yield by an extraction method, the conditions for the extraction using TTT were examined. Satisfactory results were obtained without recourse to carriers. If the extraction is made in a benzene solution with 0.1 M TTT, Y only is extracted with a yield higher than 95% at pH 6 to 9, whereas Sr remains in the aqueous phase. However, if dioxane is added before the extraction, Sr alone is separated with a yield higher than 98% at pH 8. In an expansion of these preliminary results, carrier-free Sr^{90} and Y^{90} of great purity were obtained with yields higher than 99%. (tr-auth)

1804 (CEA-tr-X-494) SEPARATION DU STRONTIUM ET DU CALCIUM PAR L'EMPLOI DE CELLOSOLVANT. (Separation of Strontium and Calcium by Means of Cellosolves). Isawa, Tsuboda, and Kasai. Translated into French from Bunseki Dagaku, 11: 1230-5(1961). 16p.

The separation of Sr from Ca by the use of Cellosolves was studied, and it was shown that butyl Cellosolve is particularly efficacious. As the boiling point of butyl Cellosolve is high, its dehydration is easy. Moreover, it is not necessary to make a preliminary transformation of the nitrates of Ca and Sr into anhydrous salts. Water can be completely eliminated by boiling. By extension of this method, the precipitation of Sr by thermal dehydration was examined by the addition of butyl Cellosolve to the aqueous solution. In the application of this method to the analysis of Sr^{90} in samples such as fallout, the alkaline earth elements are first eliminated by the usual method, and then the butyl Cellosolve separation of Sr^{90} is performed. The results have shown that this method of separation of Sr from Ca can be used in many of the cases where the fuming nitric acid method is used. (tr-auth)

1805 SEMIAUTOMATIC MACHINE FOR GROUP SEPARATION OF RADIOELEMENTS BY CATION EXCHANGE. W. G. Mathers and C. W. K. Hoelke (Atomic Energy of Canada Ltd., Chalk River, Ont.). Anal. Chem., 35: 2064-8(Dec. 1963).

A technique for performing a five-group separation of radioelements by cation exchange is described. Suitable counting sources are prepared for each group on a semi-automatic machine. Twelve samples are analyzed simultaneously, and five counting sources for each sample are obtained and counted during an 8-hour day. Total manipulation time for the analyst during this period is about 1.5 hours. Detailed analytical results are presented for two samples: a synthetic mixture of the radioelements Sb^{125}; Zr, Nb^{95}; Cs, Ba^{137}; Co^{60}; Sr, Y^{90}; Ce, Pr^{144}; and a 3.6-year-old mixture of fission products. The radioelements in the two samples report primarily in the following groups: Group I, Sb, Ru, Zr, Nb; Group II, Cs; Group III, Co; Group IV, Sr; and Group V, Y, rare earth elements. (auth)

1806 THE EFFECT OF PHOSPHATE ION ON THE ION-EXCHANGE AND SOLVENT-EXTRACTION PROPERTIES OF THORIUM. Shi Nai Chow and D. J. Carswell (Univ. of New South Wales, Kensington, Australia). Australian J. Appl. Sci., 14: 193-7(Sept. 1963).

Phosphate, which occurs with thorium in monazite, produces a deleterious effect on the extraction of thorium from this mineral. A systematic study of the effect of phosphate ion on the adsorption of thorium on an anion-exchange resin from nitric acid solutions of from 1 to 5 M is reported. The solvent extraction of thorium into tri-iso-octylamine and into tributyl phosphate under comparable conditions is also reported. (auth)

1807 SEPARATION OF THORIUM, RARE EARTH ELEMENTS, AND SCANDIUM BY THIOCYANATE-TRIBUTYLPHOSPHATE EXTRACTION SYSTEM. Hiroyuki Yoshida (Japan Atomic Energy Research Inst., Tokyo). Bunseki Kagaku, 12: 169-72(Feb. 1963). (In Japanese)

Using the system of thiocyanate-TBP-diluent, thorium, rare earth elements, and scandium can be easily separated by selecting suitable diluents. For example, thorium (1g) can be separated from small amounts of rare earth elements (10 μg) in the system of 15% TBP-carbon tetrachloride/2M ammonium thiocyanate. Scandium (~100 μg) can

be separated from thorium (~400 mg) using the extraction system of 10% TBP-chloroform/1M ammonium thiocyanate. The back extraction of the elements extracted into the organic phase is accomplished by 1 ~ 3N hydrochloric or nitric acid. (auth)

1808 SEPARATION OF ZIRCONIUM BY ETHYL ACETATE AND TTA-XYLENE EXTRACTION METHODS. Yasumitsu Uzumasa, Kenjiro Hayashi, and Saburo Ito. (Hokkaido Univ., Sapporo). Bunseki Kagaku, 12: 252-6 (Mar. 1963). (In Japanese)

A method of separation with successive two-solvent extractions is presented, in which, at first, a large amount of iron(III), chromium(VI), molybdenum(VI), and tin(IV) are separated by an extraction with ethyl acetate from 6N hydrochloric acid solution, and then zirconium is extracted with 0.5M TTA-xylene for separation from aluminum, vanadium, and titanium. As Ti^{4+} showed a similar behavior to zirconium in the latter case, hydrogen peroxide was added preliminarily. The separation of difficulty separable fluorine was made by a combined use of aluminum and TTA. Zirconium transferred into aqueous phase from TTA solution by the usual method was inapplicable for direct colorimetric determination. The organic phase was diluted with xylene, extracted with 10N sulfuric acid and this was used for direct colorimetric determination. By this method, a small amount of zirconium containing various amounts of co-existing ions was determined quantitatively. (auth)

1809 SEPARATION OF NIOBIUM AND TANTALUM WITH N-BENZOYL-N-PHENYLHYDROXYLAMINE. Masao Kawahata, Heiichi Mochizuki, Rokuro Kajiyama, and Masao Ishii. Bunseki Kagaku, 12: 296-8(Mar. 1963). (In Japanese)

1810 REDUCTION REEXTRACTION OF PLUTONIUM USING URANIUM(IV) SULFATE AND URANIUM(IV) AMIDOSULFONATE. M. Beran and S. Havelka (Inst. of Nuclear Research, Czechoslovak Academy of Sciences, Rez). Collection Czech. Chem. Commun., 28: 2510-13(Sept. 1963). (In German)

The effect of the concentration of nitric acid and tetravalent uranium and the effect of sulfonate and sulfate ions on the reduction reextraction of plutonium from organic phases containing 30% TBP in kerosene, 0.33M $UO_2(NO_3)_2$, 0.4M HNO_3, and approximately 10^{-5}M Pu were investigated. The effectiveness of the reextraction increases with decreasing concentration of nitric acid and with increasing concentration of tetravalent uranium. Sulfonic acid exerts only a small effect on the stability of trivalent plutonium, but with the addition of uranium(IV) sulfate solutions even 0.02M H_2SO_4 prevents the reverse oxidation of plutonium for 22 hr. (tr-auth)

1811 THE CO-EXTRACTION OF CALCIUM AND STRONTIUM WITH THE OXYQUINOLATES OF A NUMBER OF ELEMENTS. N. V. Shakova, I. P. Alimarin, and Yu. A. Zolotov (Vernadskii Inst. of Geochemistry and Analytical Chemistry, Academy of Sciences, USSR). Dokl. Akad. Nauk SSSR, 152: 884-7(Oct. 1, 1963). (In Russian)

The extraction of Ca^{45} and Sr^{90} as oxyquinolates from a buffered borate solution over a pH range of 6 to 11 was investigated in the absence of and in the presence of Sc, Th, and Nd. The Sr concentration was 9.1×10^{-5} mole/l, and that of Ca was 1.51×10^{-4} mole/l. The concentration of the carrier element was 2.73×10^{-4} mole/l. The organic extractant was a 0.138 M oxyquinolate solution in benzene. It was found that Ca and Sr are extracted much better in the presence of Nd, Sc, or Th than in the absence of these elements. The distribution coefficient is the same for a direct extraction from an aqueous solution as for a back-extraction from the organic phase. The extraction of Ca attains a maximum at a Sc to Ca ration of 3 : 1 with an initial pH of 9.2. The extraction of Ca increases with increasing concentration of oxyquinolate. Adsorption spectra were taken on an organic extract of Sc containing Ca and not containing Ca. A decrease in optical density was observed for the Sc solution, when Ca is added. Electrophoresis experiments showed that a mixed compound of Ca and Sc is extracted, and that Ca is present as a cation and Sc in an anion. The data are consistent with the formula $Ca(ScOx_4)_2$ for the complex, but this formula needs confirmation. The co-extraction of an element can be used to advantage in separation processes. (TTT)

1812 THE KINETICS OF ION EXCHANGE PROCESSES IN THE PRESENCE OF COMPLEXING AGENTS. N. N. Matorina, K. V. Chmutov, N. D. Safonova, and L. V Shepetyuk (Inst. of Physical Chemistry, Moscow). Dokl. Akad. Nauk SSSR, 152: 915-18(Oct. 1, 1963). (In Russian)

The kinetics of ion exchange of rare earth elements ($Eu^{152-154}$ and Ce^{144}-Pr^{144}) in the presence of ethylenediaminetetraacetic acid (EDTA), diethylenetriaminepentaacetic acid (DTPA), and citric acid (H_3Cit), was investigated. The sorption characteristics of these three acids at 30°C as a function of pH were determined by means of a cation exchange resin. It was found that the absorption of H_3Cit is a linear function of the concentration of the undissociated form. This relation does not hold for EDTA and DTPA, where the absorbed amount is always higher than the equilibrium concentration. Eu^{3+} and Ce^{3+} were absorbed from a NaCl solution onto a cation exchange resin, and were desorbed with a NaCl solution containing a complexing agent. The metal ions are supposed to be in hydrated form during absorption and in complex form during desorption. The diffusion coefficients are obtained from the Boyd equation. The internal diffusion coefficients are 4.0×10^{-7} for Eu^{3+} and 4.3×10^{-7} for Ce^{3+}. The diffusion coefficients are 2.0×10^{-8} for the Eu complex with EDTA, and 1.5×10^{-8} for the Ce complex with EDTA. The desorption of rare earths by EDTA is a diffusion process which is not affected by the dissociation of the complex. The diffusion coefficient of a hydrated metal ion decreases with increasing radius of the hydrated ion, that is, with decreasing atomic number of the rare earth element. On the other hand, the diffusion coefficient of a rare earth complex increases with increasing atomic number of the rare earth element. (TTT)

1813 THE REPROCESSING OF URANIUM–MOLYBDENUM NUCLEAR FUELS. T. Kikindai. Energie Nucl., 5: 372-6(July-Aug. 1963). (In French)

After a brief review of the processes used for the reprocessing of irradiated U fuel elements, the difficulties encountered in the reprocessing of U–Mo fuel elements for the recovery of Pu and U are examined. These difficulties occur during the dissolution of the alloy because of the low solubility of Mo in acid medium. The presence of Mo does not interfere with the extraction, but poses difficult problems, with respect to storage, during the treatment of fission products. Two possibilities for reducing the volume of the fission products, utilization of Mo-complexing agents and storage in solid form, are discussed. (tr-auth)

1814 COUNTERCURRENT EXTRACTION. II. EXTRACTION RESEARCH WITH MULTISTAGE PLATE EXTRACTOR WITH 25 STAGES. W. J. Ritschard and H. Tompa (Union Carbide European Research Associates

s.a., Brussels). Helv. Chim. Acta, 46: 1957-67(1963). (In German)

A continuous countercurrent extraction apparatus with 25 stages was constructed and tested with malonic, succinic, and glutaric acids using n-butanol and water as solvents. Mathematical formulas to describe the conditions in the apparatus and the results to be expected are given. (auth)

1815 DIRECT FRONTAL ANALYSIS. M. Randin and G. Brunisholz (Université, Lausanne, Switzerland). Helv. Chim. Acta, 46: 2107-10(1963). (In French)

A new technique, called direct frontal analysis, was developed for the investigation of ion exchange reactions. It may be used for the determination of the separation factor of ion exchange reactions and of the selectivity of ion exchangers, and for the establishment of the ratio of the stability constants of the complexes of similar ionic species. (auth)

1816 A STUDY OF THE EXTRACTION OF THORIUM NITRATE WITH TBP. Kuan Pan, Ying-Mao Chen, and Shu-Ti Lee (National Taiwan Univ., Taipai, China). J. Chinese Chem. Soc. (Taiwan), 7: 11-19(May 1960). (In English)

The distribution ratio (q) of the thorium nitrate-TBP (tri-n-butyl phosphate) system was studied by volumetric determination with EDTA (ethylenediaminetetraacetate) and radiometric determination using UX_1 as radioisotope tracer ($Th^{234}(UX_1)$ was prepared from a solution of uranyl nitrate by using the nitrate elution method). The distribution ratio was expressed by $q = (Th)_0/(Th)_a$, where $(Th)_0$ and $(Th)_a$ represent the total concentrations of Th in organic and aqueous phases, respectively. Plots of q vs concentrations of nitric acid, sodium nitrate in formality, and TBP in volume percentage are shown. It was found that the q value increases steeply up to a max at formality 5 in HNO_3 and then decreases with increasing concentration of HNO_3 up to formality 10. At constant ionic strength, the relation between q and the formality of nitrate ion is nearly linear. It was evident that addition of HNO_3 to the system results in the formation of a molecular species of a higher degree of association with nitrate ions through the common ion effect. This tends to facilitate the extraction. On the other hand, since HNO_3 passes into the organic phase to a certain extent and forms a complex compound, HNO_3 – TBP, there is a competition for solvent molecules between Th nitrate and HNO_3. This causes a decrease in the concentration of Th in the organic phase. Thus for a limited addition of nitric acid the salting-out effect is apparent and the q value increases, but when a large amount of the acid is added the competitive effect becomes dominant and the q value decreases. The two opposing effects result in the peak seen in the extraction curve. Extraction curves, obtained by plotting q vs the volume percentage at various concentrations of Th and HNO_3, suggest the following relation between q and [TBP]: $q = k[TBP]^2$ which gives confirmation of the solvate $Th(NO_3)_4$-2TBP, viz. $Th(NO_3)_n^{4-n} + (4-n)NO_3^- + 2TBP = Th(NO_3)_4 - 2TBP$. Considering the salting-out effect and the competitive effect of HNO_3, it is preferable to use solutions of high nitrate concentrations rather than those of HNO_3 of the same concentration, provided that a sufficient amount of acid be added to prevent hydrolysis of Th. A nearly complete transfer of Th into the organic phase containing 40% TBP from an aqueous phase containing 4F $NaNO_3$ was observed. The formation of Th nitrate anion was confirmed in a solution of 6F HNO_3 and applied to separation of UX_1 from uranyl nitrate solution. It was found that as the concentration of HNO_3 increased, the effect of the combined action of competition and anion formation became dominant and the q value decreased. (BBB)

1817 SEPARATION OF NEODYMIUM AND YTTRIUM BY ELUTION WITH AMMONIUM THIOCYANATE. Helga Auer-Welsbach and J. Mikler (Universität, Vienna). Monatsh. Chem., 94: 243-46(1963). (In German)

A 2 × 41-cm glass column containing the strongly acidic cation exchanger Dowex 50x8 (50-100 mesh, NH_4^+ form) was used. A mixture of Y and Nd nitrates (50% Nd by wt, estimated as oxide) was eluted from the column with 1.4N ammonium thiocyanate at a linear flow rate of 2×10^{-3} cm/sec. The eluate was collected in 8 fractions (I-VIII). Recovery was carried out by precipitation with ammonia, followed by reprecipitation with oxalic acid. About 60% of the total mixture was recovered in a pure state from the fractions by this method. Spectral analysis and magnetic susceptibility measurements showed that fractions I and II contained only Y and that fraction III contained only about 0.01% Nd as contaminant; Nd concentrations in fractions IV-VIII increased progressively from 88 to 99.96%. The experimental elution curves obtained for Y and Nd separately showed extensive overlap so that the highest purity Y_2O_3 can be obtained only in the region of the Y elution maximum. (BBB)

1818 EXTRACTION OF THORIUM FROM HYDROCHLORIC ACID SOLUTIONS BY DI-N-PENTYL SULPHOXIDE. P. K. Gaur and S. R. Mohanty (Banaras Hindu Univ., Varanasi, India). Naturwissenschaften, 50: 614 (1963).

The extraction of Th from HCl solutions by di-n-pentyl sulfoxide (DPSO) in carbon tetrachloride was reported. The percentage extraction from 7.0M HCl solutions was determined as a function of the DPSO molarity. The extraction increases with increase in DPSO concentration and is 92.5% at 1.0M DPSO. At a DPSO concentration of 0.25M, the maximum Th extraction occurs at 8M HCl. (J.S.R.)

1819 CHEMICAL PROCESSING REQUIREMENTS FOR TRANSURANIUM ELEMENT PRODUCTION. R. E. Leuze (Oak Ridge National Lab., Tenn.). Nucl. Sci. Eng., 17: 448-51(Nov. 1963).

Transuranium elements will be produced by long-term neutron irradiation of Pu–Al alloy to produce Pu^{242}, Am^{243}, and Cm^{244}, which will be irradiated in the High Flux Isotope Reactor to produce berkelium, californium, einsteinium, and fermium. Methods based primarily on ion exchange and solvent extraction are outlined for processing both irradiated Pu–Al alloy and irradiated HFIR targets. The calculated content of irradiated Pu^{242} and Cf^{252} HFIR targets is given. (auth)

1820 ISOLATION OF TRANSPLUTONIUM ELEMENTS BY TERTIARY AMINE EXTRACTION. R. D. Baybarz, B. S. Weaver, and H. B. Kinser (Oak Ridge National Lab., Tenn.). Nucl. Sci. Eng., 17: 457-62(Nov. 1963).

The Tramex Process for separating transplutonium elements from ionic impurities and fission products, including the rare earths, was developed and tested in laboratory scale experiments. The process is based on tertiary amine extraction of transplutonium elements from concentrated lithium chloride solutions. Single-stage separation factors between the transplutonium and the lanthanide elements were found to be $\geqq 100$. Extraction positions were found to be Cf > Fm > Es > Bk > Am > Cm ≫ lanthanides. Extraction coefficients were directly proportional to the square of the amine concentration in the solvent, directly proportional to the 17th power of the LiCl concentration in the

aqueous phase, and inversely proportional to the 1.3 to 2.0 power of the acid concentration in the aqueous phase. Extraction coefficients were affected by the presence of various contaminant anions and were also dependent upon the solvent used to dilute the amine. (auth)

1821 PRECIPITATION OF METAL CHELATES FROM HOMOGENEOUS SOLUTION. A REVIEW. F. H. Firsching (Univ. of Georgia, Athens). Talanta, 10: 1169-75(Nov. 1963).

A review is presented on the precipitation of metal chelates from homogeneous solution. (P.C.H.)

1822 SODIUM SEPARATION FROM BIOLOGICAL MATERIAL. N. Spronk (Oak Ridge National Lab., Tenn.). Trans. Am. Nucl. Soc., 6: 398-9(Nov. 1963).

1823 THE SHEAR-LEACH PROCESS FOR SPENT NUCLEAR FUELS. Clyde D. Watson, B. C. Finney, G. A. West, and B. A. Hannaford (Oak Ridge National Lab., Tenn.). Trans. Am. Nucl. Soc., 6: 408-9(Nov. 1963).

1824 DISSOLUTION OF HIGH-DENSITY UO_2, PuO_2, AND PuO_2/UO_2 PELLETS IN INORGANIC ACIDS. Armando L. Uriarte and Robert H. Rainey (Oak Ridge National Lab., Tenn.). Trans. Am. Nucl. Soc., 6: 410-11(Nov. 1963).

1825 SELECTIVE EXPERIMENTS IN STUDIES OF Zr AND Hf SEPARATION BY TRIBUTYLPHOSPHATE. Yu. V. Granovskii, Yu. P. Adler, V. V. Nalimov, and L. N. Komissarova. Zavodsk. Lab., 29: 1220(1963). (In Russian)

Additional data are offered for a mathematical model developed for the solvent extraction of Hf and Zr from nitric acid solutions by tributyl phosphate. (R.V.J.)

1826 SALTING-OUT IN URANIUM NITRATE EXTRACTION FROM AQUEOUS SOLUTIONS. R. T. Golovatenko (Kurnakov Inst. of General and Inorganic Chemistry, Academy of Sciences, USSR). Zh. Neorgan. Khim., 8: 2395-9(Oct. 1963). (In Russian)

Distribution coefficients for uranyl nitrate extraction from aqueous 0.04 molar solutions by diisoamyl ester of methylphosphonic acid in benzene at 10, 20, 30, 40, 50, and 60°C were measured. The salting-out mechanism of various concentrations of Mg, Ca, Co, Ni, Zn, Sr, and Cd nitrates was analyzed. (R.V.J.)

1827 EXTRACTION OF U(IV) FROM NITRIC ACID BY TRI-N-BUTYLPHOSPHATE. A. P. Smirnov-Averin, G. S. Kovalenko, and N. N. Krot. Zh. Neorgan. Khim., 8: 2400-6(Oct. 1963). (In Russian)

Experiments with solvent extraction of U(IV) from nitric acid media by TBP solution in kerosene indicate that at nitric acid concentrations below 3 M the U(IV) transition into organic phase results in a formation of $U(NO_3)_4 \cdot$ TBP solvate with formation constants of 4.51, 6.79, and 13.4 at ionic strength 1.75, 2.25, and 2.75, respectively. With nitric acid concentration over 3 M the U(IV) passes into organic phase as n TBP $H_2U(NO_3)_6$ compound. (R.V.J.)

1828 EFFECTS OF FLUORINE AND CHLORINE IONS ON ZIRCONIUM AND HAFNIUM NITRATE SOLUTIONS. G. A. Yagodin, G. E. Kaplan, O. A. Mostovaya, S. D. Moiseev, and L. P. Dmitrieva. Zhur. Neorgan. Khim., 8: 1973-9(Aug. 1963). (In Russian)

Studies of the effects of fluorine ions on Zr and Hf extraction from nitrate solutions by tributyl phosphate and diisoamyl ester of methylphosphinic acid showed that certain amounts of fluorine increase the amount of metal passing into an organic phase. The best extraction was achieved with ZrF^{3+} extracted with $Zr : F : NO_3$ ratio 1:1:1. From saturated zirconium oxychloride solutions in hydrochloric acid by TBP and DAMPA the extraction ratio was $Zr : Cl = 1 : 2$. Extraction from mixed nitrate–hydrochloric acid solutions was more efficient than from separate nitrate or hydrochloric acid solutions. The observed Zr and anion ratio 1:2 is the result of partial zirconium hydrolysis due to the low acidity in the organic phase. (R.V.J.)

1829 EXTRACTION OF RARE EARTHS AND THORIUM FROM SULFURIC ACID BY DIISOBUTYLPHOSPHORIC ACID. Z. A. Sheka and E. I. Sinyavskaya. Zhur. Neorgan. Khim., 8: 1980-6(Aug. 1963). (In Russian)

Solvent extraction of Ce(III), Er, Ho, Gd, La, Nd, Sm, Tb, Y, Yb and Th from sulfuric acid by a 0.148 molar solution of diisobutylphosphoric acid in kerosene was analyzed. It was found that each of the rare earths and thorium are fully separated at a certain concentration of sulfuric acid. Extractability of rare earth and thorium dibutylphosphates is a function of their solubility and stability in sulfuric acid. Comparisons of stability according to their equilibrium constants of the reaction indicated equilibrium constant variability from $\lg K_{La} = 17.1$ to $\lg K_{Yb} = 21.1$. Equilibrium constant for thorium was $\lg K_{Th} = 24.5$. (R.V.J.)

1830 THE SYSTEM URANYL NITRATE–WATER–TRI-N-BUTYL PHOSPHATE–CARBON TETRACHLORIDE. J. J. van Aartsen. Thesis, Delft, Netherlands, Technische Hogeschool, 1962. 110p.

A thermodynamic description is given of non-ideal behavior in binary and ternary mixtures. The relation between the equilibrium constant for the homogeneous dissociation of a binary liquid compound and the shape of the freezing-point diagram of the two components is discussed. A survey is given of the materials used, their most important physical constants, and the purification procedures applied. The values that were determined at 25°C for the equilibrium concentrations and the vapor pressures in the systems $CCl_4–H_2O–TBP$ and $UO_2(NO_3)_2–H_2O–TBP$ are stated. The experimental data concerning the quaternary system $UO_2(NO_3)_2–H_2O–TBP–CCl_4$ are tabulated. The influence of nitric acid on the extraction of UN with pure and with diluted TBP is also discussed along with the influence of other variables that are important in an effective extraction scheme. (RCN)

1831 CONTINUOUS MEASUREMENT OF HEXAVALENT CHROMIUM FOR CONTROL OF A DAREX PROCESS. T. M. Gayle and T. A. Gens. 12p. (CONF-285-2)

From 7th Conference on Analytical Chemistry in Nuclear Technology, Gatlinburg, Tenn., Oct. 1963.

The methods of potential analysis and ultraviolet analysis for continuous measurement of hexavalent chromium for control in the Darex process were investigated. Problems of continuously making exact dilutions, deaeration of the flowing sample, build-up of coatings on cell windows, optical standardization, and electronic circuit complexity combined to make the ultraviolet method somewhat impractical for continuous use. Better results were obtained with the potential analysis method. (P.C.H.)

1832 IMPROVEMENTS IN OR RELATING TO THE PURIFICATION OF EXTRACTION SOLVENTS CONTAINING TRIALKYL PHOSPHATES. Brian Orlando Field and Edward Sydney Lane (to United Kingdom Atomic Energy

Authority). British Patent 941,791. Nov. 13, 1963. Filed Oct. 10, 1960.

Degradation products in extraction solvents consisting of trialkyl phosphate in a hydrocarbon diluent can be removed by contacting the solvent with a basic liquid organic amine that is insoluble in the solvent and does not extract the phosphate from the solvent. Some suitable amines are listed. (D.C.W.)

ENGINEERING

General

1833 (AD-249100) POWER SUPPLIES. An ASTIA Report Bibliography. (Armed Services Technical Information Agency, Arlington, Va.). Jan. 1961. 313p.

References (about 1800) are included to unclassified reports in ASTIA's AD collection (1953 to present) on power supplies. Most of the references are related to power supplies for space research, but entries pertaining to more conventional applications and related topics such as space radiation are included. Information on requisition of the reports is also given. (D.C.W.)

1834 (IS-700(Sect.E)) ENGINEERING DIVISION. (Ames Lab., Ames, Iowa). 43p.

Research and development progress is reported on chemical, nuclear, mechanical, and ceramic engineering. (M.C.G.)

1835 (UCRL-10996) POWER REQUIREMENTS FOR MIXING OF LIQUID–GAS SYSTEMS. Michael Wayne Clark and Theodore Vermeulen (California. Univ., Berkeley. Lawrence Radiation Lab.). Aug. 30, 1963. Contract W-7405-eng-48. 64p.

The power requirements of agitated liquid-gas systems using both four-bladed flat-paddle impellers and a four-bladed turbine in a baffled cylindrical tank were investigated. The power-number reduction was related qualitatively to cavitation, and is correlated as a function of Weber number, geometrical factors, and the volumetric gas holdup. The gas holdup was found to vary with impeller speed and impeller dimensions, as well as gas flow rate and liquid properties. Incipient vortex formation, whereby air is introduced downward into an agitated liquid, was encountered and investigated. A correlation involving geometrical factors and the Froude number was developed to predict the onset of this phenomenon and the subsequent power-number behavior. (auth)

1836 (WT-1468) SECONDARY MISSILES GENERATED BY NUCLEAR-PRODUCED BLAST WAVES. I. Gerald Bowen, Mary E. Franklin, E. Royce Fletcher, and Ray W. Albright (Lovelace Foundation for Medical Education and Research, Albuquerque, N. Mex.). Feb. 1962. Contract [AT(29-1)-1242]. 480p.

The generation of secondary missiles by blast waves was investigated in Operation Plumbbob for three nuclear detonations with estimated yields of 11, 38, and 44.5 kt. A trapping technique was used to determine the impact velocities for 17,524 missiles (stones, glass fragments, spheres, and military debris or steel fragments) which occurred in open areas, houses, and an underground shelter with an open entryway. The equivalent ideal-wave peak overpressures computed from measured blast data for the open-area stations varied from 3.8 to 21 psi. Two houses and an underground shelter were located where the overpressures were 3.8 and 65 psi, respectively. The effect of hill-and-dale terrain on the production of missiles was investigated on one of the shots. Precursor effects were noted on two of the shots at stations near Ground Zero. Missile velocities measured at all stations except the underground shelter were compared with those computed by use of a model based on an ideal blast wave. An analytical procedure was presented by which translational velocities of man can be estimated using the measured velocities of spheres and stones. Total distances of displacement were measured for 145 stones that weighed up to 20 kg and for 1528 fragments from a concrete-block wall. (auth)

1837 ARCJET ENGINE PERFORMANCE: EXPERIMENT AND THEORY. Richard R. John, Stewart Bennett, and John F. Connors (Avco Corp., Wilmington, Mass.). AIAA (Am. Inst. Aeron. Astronaut.) J., 1: 2517-25(Nov. 1963).

Analytical and experimental results are presented on the propulsion performance and the energy addition and loss mechanisms of a radiation-cooled arcjet engine having a constricted-arc configuration. A useful lifetime of one month was obtained with such an engine operated with hydrogen at 1000-sec specific impulse, 30-kw d-c power input, and an electric to thrust power conversion efficiency of 40%. At 30-kw input power, reliable engine operation was obtained at up to 1000-sec specific impulse with ammonia and up to 1500-sec specific impulse with hydrogen. Specific impulses greater than 2000 sec were obtained using hydrogen in a radiation-cooled engine operated at 200-kw input power. Electric to thrust power conversion efficiencies were in the range from 35 to 45%. Visual examination of the arc discharge through a quartz constrictor indicated that there was a smooth, constant-diameter, luminous core extending from the cathode through the constrictor and terminating in the nozzle. Examination of experimental cool-off data and engine exterior surface temperature distributions indicated the existence of an energy transfer path from the hot engine walls to the cold incoming propellant. (auth)

1838 LEWIS TYPE BOMBARDMENT ION ENGINE: D. C. AND PULSED OPERATION. H. J. King and B. S. Quintal (Ion Physics Corp., Burlington, Mass.). AIAA (Am. Inst. Aeron. Astronaut.) J., 1: 2661-3(Nov. 1963).

The fundamentals of operation of a Lewis type electron bombardment ion engine are investigated. For d-c operation it is found that the thrust level, specific impulse, and propellant efficiency are interrelated and cannot all be chosen independently. It is shown that for a given specific impulse and maximum propellant efficiency, the thrust is directly related to engine size. The pulsed operation was studied to determine the feasibility of developing such a device for precise thrust vectoring or positioning of space vehicles. It was shown that beam-current pulses could be produced by the simple expedient of pulsing the arc voltage with the cathode, magnet, propellant flow, and high voltage in the operate mode. (C.E.S.)

1839 ELECTRIC PROPULSION FOR MANNED MISSIONS. Robert J. Denington, William J. LeGray, and Russell D. Shattuck (Lewis Research Center, Cleveland). 18p. (CONF-308-2).

From American Institute of Aeronautics Meeting on Engineering Problems on Manned Interplanetary Exploration, Palo Alto, Calif., Sept. 1963.

Electric propulsion appears to be competitive with chemical and nuclear propulsion providing lightweight, long-lived engines are developed. High specific impulse thrustors, which promise to satisfy advanced electric engine requirements, are nearing engineering phases of development. If they have sufficient life, they could serve as thrustor modules along with the megawatt powerplants.

The nuclear-electric power supply poses the most difficult problems. One of the two powerplants considered, the Rankine-cycle technology, is more advanced and has a broader technology base. In contrast, thermionic technology is in an earlier phase and predictions of its potential are less reliable. There appears to be no incentive to select either a Rankine or thermionic powerplant over the other. It appears that lightweight, high-efficiency electric engines competitive with other propulsion schemes can be developed. It is not apparent, however, that long life can be obtained unless extensive redundancy and/or in-flight repair capability are feasible. The advanced electric engines require a long and expensive development program, especially for the electric powerplant, if the reliability required for manned flight is to be realized. (auth)

1840 DESIGN OF HIGH TEMPERATURE STRUCTURAL SYSTEMS. M. A. Steinberg and H. P. Kerfoot (Lockheed Missiles and Space Co., Sunnyvale, Calif.). 35p. (CONF-135-5)

From International Symposium on High Temperature Technology, Asilomar, Calif., Sept. 1963.

The development of light-weight high-temperature structures for aerospace programs is discussed. The propulsion and re-entry environments of these systems are described and related to the design of high-temperature structural systems. The high-temperature properties of various materials are described. (C.E.S.)

1841 RADIATION-STABLE AND THERMALLY STABLE OILS. Russell A. Hunt, Jr., and Blanchard L. Mickel (to Standard Oil Co.). U. S. Patent 3,109,815. Nov. 5, 1963. Filed July 30, 1958.

A hydrocarbon oil composition is described which has improved stability in the presence of ionizing radiations and at elevated temperatures. The oil composition comprises a hydrogenated mineral oil or kerosene with 0.0001 to 1% of a dialkylbenzene sulfonate salt, e.g., sodium didodecylbenzene sulfonate. Results of radiation-thermal stability tests made on this composition are given. (D.L.C.)

Applications of Nuclear Explosions

1842 (SC-4730(RR)) THE EFFECT OF ROW CHARGE SPACING AND DEPTH ON CRATER DIMENSIONS. L. J. Vortman and L. N. Schofield (Sandia Lab., Albuquerque, N. Mex.). Nov. 1963. Contract AT(29-1)-789. 176p.

Forty row charges were fired in the Albuquerque fan-delta alluvium to define row-charge crater dimensions in terms of charge burial depth and the spacing between charges in the row. Sixty single charges were detonated at various burial depths for comparison. The factors limiting equivalence between row-charge craters and continuous line-charge craters are defined in terms of length of the row charge and also in terms of both burial depth and spacing. When the most efficient charge spacing was used, the optimum burial depth for row charges was 10% greater than the burial depth at which optimum crater dimensions were obtained from a single charge of the same weight. Channels were found to have a uniform width at a maximum charge spacing greater than the maximum spacing at which a uniform depth was obtained. The maximum spacing which produces a uniform channel width is a distance 30% greater than the crater radius of the same size charge detonated singly at that depth which produces an optimum single-crater radius. The maximum spacing for producing a uniform channel depth was found to be a distance 10% greater than the maximum single-charge crater radius in the same medium. The burst depth and spacing for the most efficient use of row charges is defined, and the loss in cratering efficiency resulting from failure to work at optimum burst depth or optimum spacing can be evaluated from information obtained from this experiment. Throwout from the single charges and row charges was examined, but no scaling was derived. (auth)

1843 (UCRL-6588) WATER CONSERVATION WITH NUCLEAR EXPLOSIVES. Gary Higgins (California. Univ., Livermore. Lawrence Radiation Lab.). Aug. 29, 1961. Contract W-7405-eng-48. 12p.

From Water for Texas Conference, College Station, Texas, Sept. 1961.

Application of nuclear explosives to water resource conservation has been one of the areas of study included in the Plowshare Program since its inception. Several possibilities, including creation of inexpensive water diversion canals, large permeable zones for waste or brine disposal or for underground recharge, and construction of surface storage basins, continue to appear attractive. Creation of new underground storage volume and salt water conversion seem, on the basis of available information, less likely to be successful. Production of earth dams by explosive emplacement is being considered. In all of these studies, which make use of data obtained from past nuclear tests, evaluation of safety problems constitutes a major effort. In many cases there is presently insufficient information to make firm conclusions, while in a few there appear to be no insurmountable safety problems. If results of studies continue to be encouraging, nuclear explosives may make possible projects which have hitherto been too large or costly to consider. These applications may be possible within the next decade or two. (auth)

Facilities and Equipment

Refer also to abstract 2119.

1844 (IS-642) DESIGN AND TEST OF A DIAPHRAGM PUMP FOR LIQUID METALS. D. E. Westerheide, J. C. Clifford, and George Burnet (Ames Lab., Ames, Iowa). [Apr. 12, 1963]. Contract W-7405-eng-82. 17p.

Details are provided on the construction and operation of a two-stage diaphragm pump successfully used for the first time in liquid metal service. From the results of a 5,376 hr test of the pump, it was concluded that it is well suited to the pumping of liquid metals at low flow rates where pulsating flow can be tolerated and also where remote operation is required. Operating temperatures and pressures are limited only by the availability of suitable materials of construction. (auth)

1845 (LADC-6079) A REPORT ON THE STATUS OF GAS LUBRICATION FOR TURBOMACHINERY. W. E. Crowe, J. H. Russell (Los Alamos Scientific Lab., N. Mex.) and B. Sternlicht (Mechanical Technology Inc., Latham, N. Y.). [1963]. Contract W-7405-eng-36. 38p. (CONF-251-2)

From Rotating Machinery for Gas Cooled Reactor Application, Gatlinburg, Tenn., Nov. 1963.

A discussion is presented concerning the reasons why gas bearings are being used in specialized turbomachinery.

An outline of the factors that must be considered in bearing selection and design is included. Gas bearing limitations and problem areas are examined. (J.R.D.)

1846 (ORNL-TM-694) THE THEORY OF OPTIMIZED INDUCTION HEATING DESIGN FOR HOLLOW CYLINDRICAL LOADS. S. H. Jury (Oak Ridge National Lab., Tenn.). Nov. 22, 1963. Contract W-7405-eng-26. 22p.

Mathematical relations were derived for the direct optimization of a cylindrical induction heating design. Tedious trial and error calculations are eliminated. Applications of the optimized design criteria demonstrate its correctness and range of application. Near optimum designs are also considered. (auth)

1847 (TID-19493) CRITICAL FLOW FOR STEAM–WATER MIXTURES. Final Report. Ralph W. Moulton (Washington. Univ., Seattle. Coll. of Engineering). Sept. 23, 1963. Contract AT(45-1)-1384. 403p.

Includes 2 theses, cataloged separately.

Two Ph. D. theses are presented and abstracted separately in NSA. One paper is on metastable critical flow of steam-water mixtures and the other is on slip ratios for the flow of steam-water mixtures at high void fractions. (N.W.R.)

For abstracts of individual papers see: 1848 and 1849.

1848 (TID-19493(Sect.2)) A STUDY OF SLIP RATIOS FOR THE FLOW OF STEAM–WATER MIXTURES AT HIGH VOID FRACTIONS (thesis). William Harrison Vance (Washington. Univ., Seattle). 204p.

Data were obtained on the ratio of the average vapor velocity to the average liquid velocity (slip ratio) for steam-water mixtures flowing adiabatically in a horizontal ½-in. ID tube. The slip ratios were computed from data taken on a specially constructed apparatus which employed the impulse plate principle to measure the forward momentum. The experimental conditions, which were all within the dispersed flow regime according to Baker's flow pattern correlation, covered a pressure range from 30 to 80 psia, flow rates of 200 to 800 lb_m/ft^2-sec, and qualities from 0.02 to 0.8. The experimental slip ratios ranged between 1 and 3.5 and were observed to decrease with increasing quality and pressure and increase with increasing mass velocity and pressure gradient. The slip ratios were empirically correlated with an average error of 8% as a function of the quality and the ratio of the mass velocity to the critical mass velocity at the same pressure and quality. A theoretical analysis of the differential equations of motion for dispersed two-phase flow showed that a significant portion of the observed average slip ratios could be accounted for by local slip between the vapor and entrained droplets, the remainder being due to a higher concentration of liquid in the low velocity region near the conduit wall. The pressure gradient was shown to be the major factor causing local slip, and very high slip ratios may be achieved at critical flow conditions due to this effect. The total pressure gradients computed by adding the acceleration pressure gradients, calculated from the empirical slip ratio correlation, to the frictional pressure gradients, predicted by the Martinelli-Nelson correlation, deviated from the experimental pressure gradients by an average of only 14%. (auth)

1849 (TID-19493(Sect. 3)) METASTABLE CRITICAL FLOW OF STEAM-WATER MIXTURES (thesis). James Earle Cruver (Washington. Univ., Seattle).

Simultaneous temperature and pressure measurements gave evidence that metastable states are present in critical steam-water flow. Both superheating (to 14.0°F) and supercooling (to 7.5°F) were indicated. Uniquely designed thermistor wall taps ascertained the fluctuating stream temperature with minimum disturbance in a 0.512-in. ID, 24-in. long uniform bore test section. Experimental conditions covered mass flow rates ranging from 88.6 to 1259.2 lbm/ft^2-sec over pressures of 14.7 to 40.5 psia and steam qualities of 0.018 to 0.971. According to Baker's flow pattern correlation, all data fell within the dispersed flow region. Critical flow data compared favorably with recent works of Faletti and Zaloudek. A unified theory of one-dimensional, adiabatic, separated, two-phase flow is presented. Increasing relative velocity between the phases initially lowers the three types of specific volumes. The momentum average specific volume minimizes when the slip ratio equals $(V_g/V_f)^{1/2}$, while the kinetic energy average specific volume reaches its minimum value at a slip ratio of $(V_g/V_f)^{1/3}$. Area average specific volume does not minimize with respect to slip ratio. Because a higher slip ratio would increase the total energy requirement for a given flow, $(V_g/V_f)^{1/2}$ was postulated to be the maximum attainable slip ratio in two-phase separated flow. Based upon that slip ratio and isentropic separated flow, a new critical flow model was developed. If metastable states are accounted for, this model predicts the combined experimental data trend of four recent investigators. However, experimental data lie an average of 21% higher than the predicted curve. Deviations from stable thermodynamic equilibrium were pressure independent over the experimental range if they were expressed as the reciprocal supersaturation ratio P_{sat}/P. This ratio depended upon quality, and the product of pressure gradient and homogeneous model velocity below critical flow. At critical flow, the reciprocal supersaturation ratio appeared to depend upon quality alone. Prediction of frictional pressure drops by the Martinelli-Nelson method is greatly affected by metastability. At critical flow, deviations from equilibrium lowered the parameter $(\chi_{tt})^{1/2}$ as much as 11%. Differences in the approach to critical flow between a gas and a vapor-liquid stream appear to be caused by the latter's increased frictional pressure drop and relative velocity. (auth)

1850 A LOW DOSE RATE COBALT 60 IRRADIATION FACILITY FOR BIOLOGICAL RESEARCH. Roger Ghys and John Masefield (Laval Univ., Quebec and Atomic Energy of Canada Ltd., Ottawa). Acta Radiol., 1: 275-87(Aug. 1963).

In view of the ever increasing interest in the effects of fallout and chronic irradiation of living organisms it has become necessary to have facilities, individually designed, to carry out such studies. Basic design principles are discussed, and the technical description of one such irradiator, designed and built at moderate cost, is outlined. Detailed isodose curves measured with the unit in situ are presented. A method for using the irradiator to simulate fallout irradiation conditions is given and the results of the first biological experiments are quoted. (auth)

1851 ELECTROMAGNETIC PUMPS. D. Karo (College of Advanced Technology, Birmingham, Eng.). Nucl. Energy, 332-7(Nov. 1963).

Some requirements of pumping systems for use in reactors are discussed. Specific application is made of electromagnetic pumps for liquid-metal-cooled reactors. A-c

and d-c conduction pumps and helicoidal pumps are discussed. (R.E.U.)

1852 STANDARD 6 IN. CHEMICAL REACTOR (Engineering Materials). (Union Carbide Nuclear Co. Y-12 Plant, Oak Ridge, Tenn.). (CAPE-1039)

This package contains 1 specification and 2 drawings. The reactor is used in reducing uranium hexafluoride to uranium metal by an exothermic reaction. The crucibles are used only once. The reactor is 14 in. deep, 7 in. in dia, and is fabricated of stainless steel tubing. Inside dimensions are $6\frac{1}{2}$ in. in dia and 13 in. deep. The stainless steel cover-plate is $\frac{3}{4}$ in. thick and $9\frac{3}{8}$ in. in dia. The magnesium oxide crucibles have outside dimensions of $12\frac{1}{4}$ in. deep and $5\frac{11}{16}$ in. in dia with walls $\frac{1}{8}$ in. thick. (F.S.)

1853 APPARATUS FOR COOLING CRYSTALS (Engineering Materials). (Brookhaven National Lab., Upton, N. Y.). (CAPE-1044)

This package contains 3 pages of descriptive text and 3 drawings. The apparatus is used in low temperature, single crystal, x-ray diffraction studies. A cold dry gas stream is used to cool the crystal while the crystal is on the goniometer head. The cold dry gas stream is surrounded by a warm dry gas stream to prevent condensation of atmospheric moisture. This system maintains a steady flow of gas with a minimum amount of attention for protracted periods of time. (F.L.S.)

1854 DENITRATION FURNACE (Engineering Materials). (Oak Ridge National Lab., Tenn.). (CAPE-1041)

This package contains 11 drawings. The furnace is used in the denitration of $Th(NO_3)_4$ to produce products that can be converted into thoria or thoria-urania sols. The sol or sol-gel is used to produce Th–U oxide fuel elements for Brookhaven National Laboratory. The Th–U oxides are compacted in tubes by vibratory methods. The $42\frac{7}{8}$ in. long rotating drum of the furnace is fabricated of 304 stainless steel. Twelve in. from one end, the drum narrows to $8\frac{1}{2}$ in. ID, and at the opposite or heater end, it narrows to $4\frac{1}{8}$ in. ID. The rotating drum is enclosed in a mild steel shell $46\frac{15}{16}$ in. long and 25 in. ID. The outside frame of steel is 7 ft 10 in. long, 32 in. wide, and 7 ft 1 in. high. (F.S.)

1855 A NEW ELECTROMAGNETIC PUMP FOR LIQUID METALS. R. S. Baker (Atomics International, Canoga Park, Calif.). New York, American Society of Mechanical Engineers, 1963, Preprint Paper 63-WA-92, 4p, $1.00. (CONF-102-16)

From American Society of Mechanical Engineers 1963 Winter Meeting, Philadelphia, Nov. 1963.

The increasing use of liquid metals has brought a demand for a reliable pump for this service. A system of pumping liquid metals by use of a combination of mechanical and magnetic principles is described. (auth)

1856 DESIGN SIMILITUDE OF LIQUID-METAL AND CRYOGENIC NUCLEAR AEROSPACE PUMPS. Clarence A. Schalla (Lockheed Missiles and Space Co., Sunnyvale, Calif.). New York, American Society of Mechanical Engineers, 1963, Preprint Paper 63-WA-54, 12p, $1.00. (CONF-102-14)

From American Society of Mechanical Engineers 1963 Winter Meeting, Philadelphia, Nov. 1963.

Characteristic data from hybrid centrifugal and axial-flow pump performance with liquefied gases and liquid metals correlate extremely well with those for water and aviation fuels. Head and capacity coefficients, affinity laws, cavitation constants, and efficiency relationships are identical. Performance differs, of course, when pumping the various liquids on any single pump, because of viscosity effects on leakage, density effects on power, and thermodynamic and transport property differences on cavitation. However, unlike those for viscous liquids, the fundamental design relationships, based on hydraulic and thermodynamic similarity and established by water-pump and aviation-fuel-pump characteristic parameters, still hold true with these less-viscous liquids. Centrifugal pumps, accordingly, are predictable in their performance with cryogenic fluids and liquid metals. Therefore, with less apprehension over reliability by virtue of a similitude use of available performance data, nuclear aerospace pumping systems should contribute an economical impetus to the realization of man-rated space-flight vehicles. (auth)

1857 MANIPULATORS FOR NUCLEAR AND OTHER HAZARDOUS ENVIRONMENTS. James K. Figenshau (General Mills, Inc., Minneapolis). New York, Society of Automotive Engineers, 1963, Preprint 727B, 13p. (CONF-191-6)

From Society of Automotive Engineers National Aeronautic and Space Engineering and Manufacturing Meeting, Los Angeles, Sept. 1963.

The environmental protection for typical manipulative devices is described; and design parameters, methods of operation, design features, construction materials, and (where possible) operating experience are discussed for a variety of hazardous environments. (auth)

1858 METHOD AND APPARATUS FOR UNIFORMLY IRRADIATING AN OBJECT WITH ELECTRONS. James Albert Knowlton, Jr., and Richard Harold Arndt (to General Electric Co.). U. S. Patent 3,109,931. Nov. 5, 1963. Filed June 20, 1960.

A method is described for scanning an electron beam over a beam generator window to obtain a uniform beam energy distribution over the irradiated object. For objects at relatively great distances from the window, an initially uniform electron density distribution rapidly becomes nonuniform with a high density in the center of the beam owing to scattering in air. This scattering effect may be circumvented by providing at the window a non-uniform electron beam with high density toward the edges. Several ways are described for obtaining such an electron beam, e.g., two separate, side-by-side electron beam generators, and, a single electron generating tube with a virtual double source of electrons. The latter way may be effected by overloading the resonant transformer to skew the electron beam distribution with respect to time. (D.L.C.)

Heat Transfer and Fluid Flow

1859 (AE-106(2nd rev. ed)) MEASUREMENTS OF VOID FRACTIONS FOR FLOW OF BOILING HEAVY WATER IN A VERTICAL ROUND DUCT. S. Z. Rouhani and K. M. Becker (Aktiebolaget Atomenergi, Studsvik, Sweden). Sept. 1963. 30p.

Measurements are reported of void fractions for flow of boiling heavy water in a vertical round duct with 6.10 mm inner diameter and a heated length of 2500 mm. The following ranges of variables were studied and 149 void fraction measurements were obtained.

Pressure	$7 < p < 60$ bars
Steam quality	$0 < x$ 0.38
Surface heat flux	$38 < q/A < 120$ w/cm^2
Mass velocity	$650 < m/F < 2050$ kg/m^2 sec
Void fraction	$0.24 < \alpha < 0.88$

The measurements were performed by means of a method, which is based on the (γ,n) reaction, occurring when heavy water is irradiated by gamma ryas. The results are presented in diagrams, where the void fractions and the slip ratios are plotted against the steam quality with the pressure as a parameter. The data were correlated by curves, and the scatter of the data around the curves is less than ±5 per cent. (auth)

1860 (CEA-2276) INFLUENCE DU FLUX DE CHALEUR ET DE LA NATURE DU GAZ SUR LES COEFFICIENTS D'ÉCHANGE ET LE FROTTEMENT DANS UN TUBE CYLINDRIQUE LISSE. (Influence of the Heat Flux and of the Gas on Heat Transfer and Friction Coefficients in a Smooth Cylindrical Tube). Jacques Pierre Delpont (France. Commissariat à l'Énergie Atomique. Centre d'Études Nucléaires, Saclay). 1962. 78p.

Thesis submitted to Université, Paris.

A stainless steel tube, heated by d-c current, was used in the experiments. Special care was taken (heated jacket) to avoid heat loss and to provide very accurate measurements. The cooling gases tested were air and carbon dioxide at pressures of 2.6 to 19 psi. The Reynolds number ranged from 70,000 to 10^6, and the wall temperature and the heat flux reached, respectively, 430°C and 16 watts/cm^2. The Reynolds number Re_m, Stanton number M_m and friction coefficient f were computed by evaluating the physical properties of the gases at the mean temperature T_m. For a given Reynolds number, a decrease of M_m and of f was observed when the heat flux increased; this decrease reached 10%. A formulation is proposed to express this effect in terms of a heat flow parameter $T_p - T_m/T_p$ used as a corrective factor (T_p = wall temperature). (auth)

1861 (CONF-117-9) MEASUREMENT OF DYNAMIC SURFACE TENSION IN BUBBLING SYSTEMS. John B. Roll and John E. Myers (Purdue Univ., Lafayette, Ind.). 1963. Contract AT(11-1)-122. 25p.

From American Chemical Society 145th National Meeting, New York, Sept. 1963.

The static and dynamic surface tension was measured for aqueous solutions of eleven surface-active agents for the purpose of studying the effect of surface tension upon boiling heat transfer. The surfactants were chosen from the Tween, Aerosol, and Hyonic series. Dynamic surface tension, at T = 90°C, was investigated by observing the volume and frequency for air bubbles forming from a submerged orifice. Static surface tension, at T = 100°C, was measured using a duNouy tensiometer. In all cases, the dynamic surface tension for solutions of these surface active agents was less than the value for pure water, greater than the static value for the same concentration, and was a smoothly decreasing function of concentration. (auth)

1862 (CRT-1170) SEMI-ANALYTIC CALCULATION OF THE TEMPERATURE DISTRIBUTION IN A PERFORATED CIRCLE. J. M. Kennedy and J. K. Fowler (Atomic Energy of Canada Ltd., Chalk River, Ont.). Sept. 1963. 27p. (AECL-1835)

The flow of heat in a tube-in-shell fuel element is closely related to the two-dimensional heat flow in a circular region perforated by a number of circular holes. Mathematical expressions for the two-dimensional temperature distribution were obtained in terms of sources and sinks of increasing complexity located within the holes and beyond the outer circle. A computer program, TINS, which solves the temperature problem for an array of one or two rings of holes, with or without a center hole, is also described. (auth)

1863 (GEAP-4358) MULTIROD (FOUR-ROD) CRITICAL HEAT FLUX AT 1000 PSIA. John E. Hench (General Electric Co. Atomic Power Equipment Dept., San Jose, Calif.). Sept. 1963. Contract AT(04-3)-189. 22p.

Multirod critical heat flux data were obtained with a geometry representative of present reactor design. The purpose of obtaining these data was to establish whether or not the critical heat flux is strongly related to the number of rods in the flow system. This series of experiments was conducted with a four-rod geometry. (auth)

1864 (GEAP-4362) TWO-PHASE PRESSURE LOSSES. Quarterly Progress Report No. 6, May 12, 1963–August 12, 1963. E. Janssen and J. A. Kervinen (General Electric Co. Atomic Power Equipment Dept., San Jose, Calif.). Sept. 1, 1963. Contract AT(04-3)-189. 32p.

The pressure drops along 0.75-, 1-, and 1.25-in. straight pipes and across three contraction-expansion inserts in a 1-in. pipe were measured under both single- and two-phase flow conditions. Pressure was varied from 600 to 1400 psia, flow from 0.25×10^6 to 1.66×10^6 lb/hr ft^2, and quality from zero to 90%. The single-phase pipe friction factor agrees with the Moody value for smooth pipe. The two-phase friction for horizontal flow shows no size effect in the range of pipe sizes from 0.75 to 1.25 in. The values lie below the Martinelli curve at the lower qualities ($x < 0.6$), but at high qualities tend to be above the Martinelli curve. The single-phase loss coefficient for the three contraction-expansion inserts show very little Reynolds number effect in the range of channel Reynolds numbers from 3×10^4 to 5×10^5. The two-phase data for insert number 1 were not reduced. The two-phase loss for insert numbers 2 and 3 lies generally below the loss prediction based on a homogeneous flow model. The two-phase loss for insert number 2 shows excellent agreement with the corresponding loss for the S-1 insert in the 0.50 by 1.75-in. rectangular channel ($A_0/A_1 = 0.4$, $L_0 = 0.1$ in.). The two-phase loss for insert number 3 agrees fairly well with the loss for the S-5 insert ($A_0/A_1 = 0.6$, $L_0 = 0.1$ in.). (auth)

1865 (GEAP-4367) A PROGRAM OF TWO-PHASE FLOW INVESTIGATION. Quarterly Report No. 2, July–September 1963. F. W. Staub and N. Zuber (General Electric Co., Schenectady, N. Y. and General Electric Co. Atomic Power Equipment Dept., San Jose, Calif.). Oct. 1963. Work Performed under United States–Euratom Joint Research and Development Program. Contract AT (04-3)-189. 95p. (EURAEC-866)

The design, development, and modification of a heat transfer loop for studying two-phase flow are described. With the exception of the insulation of modified components, the experimental facility is complete. The system is charged with Refrigerant-22. Preliminary loop performance tests were made without the test sections. The stainless steel test section was prepared complete with end flanges and pressure tap locations. Test section inlet and discharge assemblies are being completed. The design and construction of the test stand is nearing completion. Collimators and the detector cooler are being completed. Pressure and temperature transducers for the test section are being designed and developed. The power supply for the test section is nearing completion. The destabilizing effect of the vapor thrust on a liquid film flowing over a heated surface was considered and relations

which predict the destruction of such a film under these conditions were derived. The stability of dry patches in a liquid film flowing over a heated surface is analyzed. (N.W.R.)

1866 (GEAP-4390) TRANSITION BOILING HEAT TRANSFER PROGRAM. Third Quarterly Progress Report, July–September 1963. E. P. Quinn, ed. (General Electric Co. Atomic Power Equipment Dept., San Jose, Calif.). Oct. 1, 1963. Contract AT(04-3)-189. 20p.

Initial critical heat flux, transition boiling temperature fluctuation, and film boiling coefficient data were obtained on a two-rod cluster assembly at 1000 psia and 25 to 90% steam qualities. A representation showing the range of critical heat flux data is presented, and typical temperature recordings that indicate transition and film boiling behavior are shown. Fabrication of a new high pressure observational test section is nearly complete. An optical table and illumination system was built and operationally tested for photographic use on the new observational section. (auth)

1867 (NYO-10487) QUARTERLY PROGRESS REPORT [ON TWO-PHASE FLOW]. G. B. Wallis, D. A. Steen, and S. N. Brenner (Dartmouth Coll., Hanover, N. H. Thayer School of Engineering). July 1963.

Work Performed under United States–Euratom Joint Research and Development Program. Contract AT(30-1)-3114. 51p. (EURAEC-890)

A description is given of studies of certain fundamental two-phase flow phenomena, such as the stability of annular flow against entrainment, flood-wave formation, and the onset of bridging, which leads to slug flow. A simplified analysis of the motion of slug-flow bubbles in a very viscous fluid is appended. (auth)

1868 (TID-19661) BASIC EXPERIMENTAL STUDIES OF BOILING FLUID FLOW AND HEAT TRANSFER AT ELEVATED PRESSURES. BiMonthly Progress Report, September and October 1963. B. Matzner (Columbia Univ., New York. Engineering Research Labs.). Nov. 4, 1963. Contract AT(30-3)-187. 2p. (BPR-XIII-9&10-63)

Plans were made to obtain burnout data at pressures up to 1500 psia for three test sections. The tests will be on ¼- and ½-in. ID internally cooled tubes and three ½-in. ID internally cooled tubes to be operated with parallel flow. (auth)

1869 (WAPD-T-1290) TRANSIENT BOILING IN SMALL RECTANGULAR CHANNELS (thesis). Alfred J. Martenson (Westinghouse Electric Corp. Bettis Atomic Power Lab., Pittsburgh). June 1963. Contract AT(11-1)-Gen-14. 223p.

Heat transfer in small-channel boiling regimes was studied. It was found that the basic heat transfer mechanism for exponential transients with periods as short as 5 msec is the same as steady state and that heat transfer coefficients and burnout fluxes are higher for fast transients. Other results indicate that only a few per cent of the heat transfer is related to the latent heat of the steam at pressures up to 1000 psia. The boiling heat transfer process is observed to have an inertia. A description of the test apparatus and procedure are included along with other discussion of results. (J.R.D.)

1870 A BOUNDARY-LAYER PROBLEM ASSOCIATED WITH MAGNETOGASDYNAMIC CHANNEL FLOW. F. E. C. Culick (California Inst. of Tech., Pasadena). AIAA (Am. Inst. Aeron. Astronaut.) J., 1: 2666-8(Nov. 1963).

Flow in a channel as a possible means of energy extraction or addition is considered in connection with the motion of electrically conducting fluids through electric and magnetic fields. The analysis, based on the one-dimensional approximation, excludes the effects of viscous stresses and heat flux. The results are restricted to the necessary conditions for the existence of a class of similarity solutions to a particular set of boundary-layer equations for compressible flow. (C.E.S.)

1871 MAGNETOHYDRODYNAMIC NOZZLE. F. N. Khabeta. AIAA (Am. Inst. Aeron. Astronaut.) J., 1: 2699-2700(Nov. 1963).

The one-dimensional steady-state motion of a completely ionized gas in a channel of constant cross section and acted upon by external crossed electric and magnetic fields of constant magnitude is considered. Expressions for the current flowing through the gas and for the electric power consumed in acceleration are derived. (C.E.S.)

1872 SOME EFFECTS OF THE ORIENTATION OF THE HEATING SURFACE IN NUCLEATE BOILING. P. M. Githinji and R. H. Sabersky (California Inst. of Tech., Pasadena). J. Heat Transfer, 85: 379(Nov. 1963).

The effects of the orientation of the heating surface in nucleate boiling was studied under conditions of free convection. The experimental apparatus was arranged so that the same heating surface could be tested in various positions with respect to the gravitational field without altering any of the other test conditions. The results confirmed the fact that the orientation of the heating surface in respect to the direction of the gravitational field is of major importance in nucleate boiling heat transfer. (P.C.H.)

1873 A NOTE ON FIN-TUBE VIEW FACTORS. Henry C. Haller and Norbert O. Stockman (Lewis Research Center, Cleveland). J. Heat Transfer, 85: 380-1(Nov. 1963).

The correct derivation of the view factor of fin-tube radiators is presented. Equations that give the view factor for an elemental area on the fin were integrated over the entire fin area from tube to tube to obtain an overall view factor from the fin to space. (P.C.H.)

1874 HEAT FLOW IN CONNECTED MEDIA OF DIFFERENT TEMPERATURE-DEPENDENT CONDUCTIVITIES. R. B. Lazarus (Los Alamos Scientific Lab., N. Mex.). Rev. Sci. Instr., 34: 1218-19(Nov. 1963). (LADC-5805)

In slab or cylindrical geometry, it is shown that the total heat flow through parallel, homogeneous channels is the same, regardless of the state of thermal contact between them, even if the channels have conductivities which are different functions of temperature. (auth)

1875 A HEAT-MASS ANALOGY FOR FISSION-PRODUCT DEPOSITION FROM GAS STREAMS. M. N. Ozisik (Oak Ridge National Lab., Tenn.). Trans. Am. Nucl. Soc., 6: 265-7(Nov. 1963).

1876 ON THE ANALOGY BETWEEN EDDY CURRENTS AND TEMPERATURE AND ITS APPLICATION TO HEAT-CONDUCTION PROBLEMS. G. Cinelli (Argonne National Lab., Ill.). Trans. Am. Nucl. Soc., 6: 335-6(Nov. 1963).

1877 THE PREDICTION OF VOID VOLUME IN SUBCOOLED NUCLEATE POOL BOILING. E. E. Duke (Internuclear Co., Clayton, Mo.). Trans. Am. Nucl. Soc., 6: 337(Nov. 1962).

1878 COMPARISON OF PARTIAL ROUGHENING OF THE SURFACE OF FUEL ELEMENTS WITH OTHER WAYS OF IMPROVING THERMAL PERFORMANCES OF

A NUCLEAR REACTOR. Gilbert B. Melese (General Atomic Div., General Dynamics Corp., San Diego, Calif.). Trans. Am. Nucl. Soc., 6: 337-8(Nov. 1963).

1879 FLUID AND THERMAL TECHNOLOGY. p.54-62 of "Power Reactor Technology. Vol. 6, No. 4."

A survey is made of the literature on liquid-metal heat transfer. The current experimental programs on liquid-metal boiling and heat transfer are outlined briefly. Correlations of liquid fraction in two-phase flow are given. Burnout predictions are considered. A literature survey is also presented on boiling-water heat transfer and fluid dynamics. A study of two-phase flow distributions in an air–water system is described. Boiling burnout experiments are also described. (D.L.C.)

1880 AN ANALYSIS OF BURNOUT CONDITIONS FOR FLOW OF BOILING WATER IN VERTICAL ROUND DUCTS. K. M. Becker and P. Persson (Aktiebolaget Atomenergi, Studsvik, Nykoping, Sweden). New York, American Society of Mechanical Engineers, 1963, Preprint Paper 63-WA-51, 10p. (CONF-102-12)

From American Society of Mechanical Engineers 1963 Winter Meeting, Philadelphia, Nov. 1963.

A method of predicting the burnout conditions for flow of boiling water in vertical round ducts is presented. The analysis predicts that the burnout conditions are independent of the length-to-diameter ratio and the inlet temperature, and that the burnout steam quality decreases with increasing surface heat flux and increasing mass velocity. It is also found that the burnout steam quality at low pressures increases with the pressure and reaches a maximum at approximately 70 kg/cm^2, and thereafter decreases with a further increase of the pressure. The theoretical result compares well with experimental data. (auth)

1881 PHOTOGRAPHIC STUDY OF NUCLEATE POOL BOILING ON A HORIZONTAL SURFACE. R. F. Gaertner (General Electric Research Lab., Schenectady, N. Y.). New York, American Society of Mechanical Engineers, 1963, Preprint Paper 63-WA-76, 11p. (CONF-102-13)

From American Society of Mechanical Engineers 1963 Winter Meeting, Philadelphia, Nov. 1963.

A photographic study was made of saturated nucleate pool boiling at a pressure of one atmosphere. Over 1000 still photographs and 12 high-speed motion pictures were taken of water boiling from a 2-in-dia flat horizontal surface facing upward. Two surfaces were studied, a 2/0 polished platinum surface and a 4/0 polished copper surface. The platinum surface was studied in the heat flux range of 14,700 to 176,000 Btu/hr/sq ft, and the copper surface from the incipient boiling heat flux of 10,500 Btu/hr/sq ft to the maximum flux of 493,000 Btu/hr/sq ft. Data were obtained for the breakoff diameters of discrete bubbles, and for the populations of active sites at heat fluxes up to 58,600 Btu/hr/sq ft. At least three, and possibly four, heat-transfer regions were found to exist in nucleate boiling, depending upon the mode of vapor generation. The vapor structures on the surface progressed through a sequence of, first, discrete bubbles, then vapor columns and vapor mushrooms, and finally vapor patches as the surface temperature was increased. These individual vapor structures, or combinations of them, the mechanism of heat transfer in the four nucleate boiling regions. It was concluded that any heat-transfer model or design equation based on the dynamics of individual bubbles, or on any other single mechanism, must be in serious error. (auth)

Materials Testing

1882 (KAPL-2292) SOR-II. A PROGRAM TO PERFORM STRESS ANALYSIS OF SHELLS OF REVOLUTION. J. A. Mirabal and D. G. Dight (Knolls Atomic Power Lab., Schenectady, N. Y.). Sept. 15, 1963. Contract W-31-109-eng-52. 82p.

SOR-II, a FORTRAN program that solves for the forces, deflections, stresses, and strains in thin shells of revolution with variable thicknesses and elastic moduli, is described. The axisymmetric loadings considered include arbitrary distributions of normal, tangential, and moment surface loadings, as well as edge forces and deflections. The effects of temperature variations in the meriodional and thickness directions as well as centrifugal loading due to rotation about the axis and vibration are included. The program will solve and join together up to 20 shells. The additional effects of misalignment, line loads, and elastic supports at the shell inter-sections are considered. The shell equations are numerically integrated using a generalized Adams-Moulton method. (auth)

1883 (NP-tr-1076) A RECORDING TESTING APPARATUS FOR REFRACTORY METAL DISCS. A. Pohler and H. Stoellner. Translated by R. R. Inston (U.K.A.E.A. Atomic Energy Research Establishment, Harwell, Berks, Eng.), from Plansseber. Pulvermet., 11: No. 1, 18-19 (1963). 4p.

The construction and the function of a testing apparatus for ultrasonic echo-testing of refractory metal discs is described. The unit permits one to localize and to record continuously and non-destructively flaws with a scanning mechanism. (auth)

Protective Structures

1884 (AD-422046(p.55-85)) STRESSES IN THE VICINITY OF DEEP UNDERGROUND SHELTERS. C. J. Costantino (Illinois Inst. of Tech., Chicago. Armour Research Foundation).

The results of an investigation of stress distribution about unlined cavities are presented for use in the design of deep underground tunnel problems. The objective of this study was to collect and evaluate information required in the design of deep underground shelters. Stress concentration factors are presented for both two- and three-dimensional problems, together with a discussion of the effects of both anisotropy of material properties and dynamic loads. Design recommendations are made for three-dimensional problems for which no theoretical solutions exist, namely, tunnel intersections, bends, and shafts. Preliminary results of a recent experimental program on these special problems are also included. (auth)

1885 (AD-422046(p.92-105)) THE STATIC LIMITS OF DISTORTION OF TUNNELS SUBJECTED TO DYNAMIC BLAST LOADS. Harry L. Callahan (Black and Beatch Consulting Engineers, Kansas City, Mo.).

Circular tunnel sections are used extensively in underground protective construction for connecting major elements of complexes and as individual structures. For the most part, these structures have been, and are, designed as flexible structures possessing relatively little inherent bending strength. A large part of their ability to support vertical loads must be derived from passive pressures induced as the sides of the structure move outward against the earth. It is apparent that the integrity of such a structure is dependent upon the characteristics of the backfill

adjacent to the sidewalls. Due to the depth of fill usually involved, construction techniques, and the urgency of construction, the critical phase of backfilling frequently is not properly performed with the result that structures are distorted out-of-round as a result of the static earth loads. A procedure is developed for determining the probable deflection which will occur under dynamic blast loadings on a structure (tunnel section) which has already been distorted out-of-round as a result of static loading. Normal static design and dynamic design procedures for buried tunnel sections are reviewed. Static failure criteria is reviewed, and a procedure is presented for determining the maximum allowable static distortion of a tunnel section which will not fail during or subsequent to dynamic blast loading. Since the procedure for determining the vertical deflection has not been tested in field tests, the results are compared to other theoretical studies. Correlation is obtained by comparing the vertical deformation of an earth column of the same depth as the tunnel section. The modulus of horizontal subgrade reaction is determined from the amount of deflection that has occurred in the distortion of the structure due to static loading. The vertical modulus of deformation is determined by utilizing the modulus of horizontal subgrade reaction. From the vertical modulus of deformation, the vertical displacement of an equivalent earth column under blast load is obtained. The vertical displacement is compared to the calculated dynamic deflection of the tunnel section. The discussion includes the difficulties involved in making satisfactory evaluations, areas where the procedure is conservative, and areas where field tests would provide desirable correlation. (auth)

1886 (AD-422046(p.151-68)) AIR BLAST LOAD REDUCTION ON ABOVEGROUND STRUCTURES. Fred C. Finlayson (General American Transportation Corp. MRD Div., Niles, Ill.).

A study was made of the feasibility of using aerodynamic spoilers or deep pits, or both, to reduce air blast loads on aboveground entrances to hardened aircraft shelters. Data were obtained on two-dimensional models in a shock tube where overpressures of 400 psi were simulated. Impulse reductions of from 35 to 78 percent were shown to be obtainable with practical aerodynamic spoilers. (auth)

1887 (AD-422046(p.169-87)) DISPLACEMENT AND ACCELERATION SPECTRA FOR AIR-INDUCED GROUND SHOCK. W. L. McCabe, C. C. Mow, and M. L. Baron (Mitre Corp., Bedford, Mass.).

A treatment is presented of the ground shock environment for underground structures in the superseismic region in which the air-induced shock effects are predominant. The effects of rise time and pressure-wave diffraction by tunnels on free field shock spectra are evaluated. Free field shock spectra are presented for sharp fronted pressure waves in the 500- to 2000-psi overpressure range for weapon yields of 5 to 30 megatons. (D.L.C.)

1888 (WT-7) THE EFFECTS OF ATOMIC WEAPONS ON GLAZING AND WINDOW CONSTRUCTION. Walton C. Clark (Public Buildings Service, Washington, D. C.). Aug. 1951. ANNEX 3.5 OF SCIENTIFIC DIRECTOR'S REPORT OF ATOMIC WEAPON TESTS AT ENIWETOK. 1951. OPERATION GREENHOUSE. 79p.

Various types of wood, steel, and aluminum window construction, glazed with plastic and different kinds of glass, were installed on four sides of a test structure during the greenhouse tests in order to determine their relative resistance to an atomic blast. The degree of protection from flying glass provided by mounting Venetian blinds, insect screens, and $\frac{1}{4}$-in. mesh wire netting on the inside of window openings was also determined. The best results seem to indicate that the resistances of different types of glass to an atomic blast are approximately proportional to their strength in supporting static loads. Glass mounted in a rigid frame is less likely to be broken than if mounted in a flexible frame which may be distorted by the blast. Fragments from wire or safety glass are less dangerous to personnel than fragments from other types of glass, and plastic is less likely to break than glass. Commercial types of Venetian blinds and insect screens afforded little or no protection against flying glass fragments at the distance at which tested; however, a blind with some of the parts reinforced and properly anchored to the window opening would probably give some protection at a distance of 3 miles from the explosion or if closed, would probably give full protection against heat waves at 2 miles. Wire netting with $\frac{1}{4}$-in. mesh installed on the inside of window openings proved effective in stopping all except very small glass fragments. Lightweight, double-hung, wooden windows with sashes glazed with small panes supported by narrow muntins offer little resistance to an atomic blast. Although much valuable data were obtained, it was concluded that additional investigations are needed. (auth)

1889 (WT-510) INCENDIARY EFFECTS OF ATOMIC BOMB TESTS ON BUILDING SECTIONS AT YUCCA FLAT. H. D. Bruce (Forest Products Lab., Madison, Wis.). Oct. 1952. Project 8.5 of OPERATION SNAPPER. 47p.

Sections simulating four types of frame building structures were exposed to TUMBLER Shots 3 and 4. The four types were: (1) cubicle room with furnishings, (2) wall-corner, (3) cornice-corner, and (4) roof. Sections 2 and 3 were exposed with and without a fine flash fuel. Douglas-fir springwood was charred at least slightly out to about 13,000 feet (radiant exposure 4.0 cal/cm^2) by Shot 3 and about 10,000 feet (radiant exposure 5.1 cal/cm^2) by Shot 4. Sustained burning, either as glowing or flaming, took place only in fine fuels. It was concluded that the flash of radiant energy from an atomic explosion will set sustained primary fire in fine fuel, but in general not in more massive fuels such as lumber and plywood. It is recommended that field study of primary fires on building structures be confined to fine fuels to ascertain the conditions under which they become ignited to self-sustaining fire and to such other shapes and materials as may be shown by laboratory experimentation to be a possible fuel for sustained primary fire. (auth)

Vacuum Engineering

1890 BACKSTREAMING IN BAFFLED SYSTEMS. William M. Langdon and Edward G. Fochtman (IIT Research Inst., Chicago). 18p. (CONF-209-5)

From American Vacuum Society Meeting, Boston, Oct. 1963.

Backstreaming characteristics of DC 704, DC 705, and Convalex 10 oils were measured in a baffled pumping system consisting of a 6-inch fractionating pump with a cold cap and either a chevron trap or a right-angle elbow. The system operated at a pressure of 10^{-8} to 10^{-9} torr, and testing periods varied from 3 to 60 days. Trap temperatures were varied from room temperature to liquid nitrogen temperature in the stations employing a chevron trap

and from room temperature to 5°C in the stations employing the elbow baffle. Back-streaming, measured by ultraviolet absorption spectra of the collected oil, ranged from 1×10^{-8} mg/(cm^2) (min) for DC 704 to 3×10^{-9} mg/(cm^2) (min) for Convalex 10. In well-designed traps backstreaming of liquid drops appears to cause more contamination than gaseous backstreaming. (auth)

1891 SOME CHARACTERISTICS OF UNITARILY DESIGNED ULTRA HIGH VACUUM PUMPING GROUPS BASED ON DIFFUSION PUMPS. B. D. Power, N. T. M. Dennis, and L. de Csernatony. 23p. (CONF-209-3)

From American Vacuum Society Meeting, Boston, Oct. 1963.

A pumping group incorporating a 'Z' cold trap, chevron thermoelectrically cooled baffle, mercury diffusion pump and high-backing-pressure backing diffusion pump exhausts into a backing capacity evacuated by sorb pumps. Unitary design avoids demountable joints from inlet flange to below pump top stage. Organic-free construction is possible. Very low pressures can be achieved and recovered, after trap failure, without rebaking. Great freedom from organic contamination is demonstrated. Investigation of the gases accumulating in the backing capacity indicates the progress of the bake and the nature of the gases released during baking. A similar group employing an oil pump is described. (auth)

GEOLOGY AND MINERALOGY

General

Refer also to abstract 2284.

1892 PRESERVATION STATE OF RADIOGENIC ARGON IN GLAUCONITES. S. S. Sardarov (Makhachkala Inst. of Geology, Daghestan Branch of Academy of Sciences, USSR). Geokhimiia, No. 10, 905-11(Oct. 1963). (In Russian)

Experimental data and theoretical calculations are given concerning the practically complete preservation state of radiogenic argon in glauconites and the possibility of establishing the true absolute age of sedimentary rocks by the argon method. Further the bond between the isolation of structural water and radiogenic argon from the mineral and their activation energy is shown. A new method of counting the activation energy values of radiogenic argon is also given. (auth)

1893 ON THE GEOCHEMISTRY OF NIOBIUM AND TANTALUM IN CLAYS. D. N. Pachadzhanov (Vernadskii Inst. of Geochemistry and Analytical Chemistry, Moscow). Geokhimiia, No. 10, 930-42(Oct. 1963). (In Russian)

With the aid of the spectral method with a preliminary enrichment in tannin, the niobium and tantalum content was determined in some humid and arid clays of the Russian platform. The investigated samples were composed of 354 specimens. The average content of niobium in humid clays is 0.0020%, of tantalum 0.00024% (the Nb/Ta ratio is 8.4) and in arid clays is respectively the content of niobium 0.00133% and the content of tantalum 0.00009% (the Nb/Ta ratio is 14.8). The average value of the content of niobium content for all studied clays is 0.00183% and of the tantalum content 0.00020%, the Nb/Ta ratio being 9.1. In clays an interconnection of niobium with tantalum, as well as with aluminium, titanium, zirconium, and hafnium was observed. However, on the background of this connection some separation of the named elements is noted. A tendency for the Nb/Ta ratio shift from the region of matter removal towards the center of the marine basin was observed. The study of niobium and tantalum distribution over different clay fractions showed that one part of elements is connected with zircon and titanium minerals in aleurosand fraction (0.1–0.01 mm). Another, approximately similar part is contained in the proper clay fraction (<0.001 mm), the tantalum somewhat more concentrating in the aleurosand fraction and niobium in the clay fraction. (P.C.H.)

1894 RATIO OF Zr/Hf IN A ZIRCON FOUND IN NORTH KAZAKHSTAN IGNEOUS ROCKS. A. V. Kosterin, I. D. Shevaleevskii, E. K. Rybalova, and K. P. Tolok (Far East Inst. of Geology, Academy of Sciences, USSR). Geokhimiia, No. 10, 966-8(Oct. 1963). (In Russian)

An x-ray spectral analysis was made of the Zr/Hf ratio in the igneous rocks of Northern Kazakhstan. It was found that in the third intrusion group the ratio Zr/Hf diminishes from the basic rock to acid (for instance in a zircon of melanocratic quartz monzonite the Zr/Hf ratio is 66 and in more acid microclinic granites it drops to 52). In the second intrusion group such regularity was disturbed by assimilation of surrounding rock which interfered with the ordinary magmatic differentiation processes. (R.V.J.)

1895 DISCORDANT LEAD–URANIUM AGES DUE TO CONTINUOUS LOSS OF LEAD. T. J. Ulrych (Univ. of Western Ontario, London, Ont.). Nature, 200: 561-2 (Nov. 9, 1963).

It is shown that linear relationships observed in discordant lead–uranium ages are not specific to episodic and diffusion loss mechanisms, but occur for many loss processes. (P.C.H.)

1896 TRITIUM RETENTION IN IRON METEORITES. David Tilles (Smithsonian Astrophysical Observatory, Cambridge, Mass. and Harvard Coll. Observatory, Cambridge, Mass.). Nature, 200: 563-4(Nov. 9, 1963).

Experimental evidence is cited that contradicts a previously reported assumption that tritium disappears quickly from most iron meteorites or iron targets. It is shown that even for samples measured about 40 years after the fall of the meteorite and the cessation of tritium production, tritium is measurable, and in most cases the extrapolated activity is the same in different samples within a factor of two or three. (P.C.H.)

1897 DIFFUSION OF TRITIUM OUT OF IRON SAMPLES IN RELATION TO TRITIUM CONTENT IN METEORITES. Henry Dubost and Marc Lefort (Faculté des Sciences, Paris and Université, Paris). Nature, 200: 566 (Nov. 9, 1963).

Pure iron sheets were bombarded with proton beams at 85 to 155 Mev. Tritium was extracted from several iron sheets from the same irradiation but at different times after irradiation. The longer the iron sheet remained the less tritium was found. It was found that tritium was diffusing out of the target at a fast rate. The diffusion rate was found to be proportional to the logarithm of time. Half the tritium left the target in 70 days and the cross section value changed from 14 mb when the extraction was made shortly after irradiation, to 3 mb when it occurred more than 2 years later. (P.C.H.)

1898 MINING AND METALLURGY QUARTERLY. Elizabeth Tornquist, ed. Translation of Rudarsko-Met. Zbornik, No. 1, 1963. 89p. (OTS-63-11450-1). $1.00 (OTS).

A translation of Rudarsko-Met. Zbornik (Mining and Metallurgy Quarterly), No. 1, 1963, is presented. Separate abstracts were prepared for two of the seven articles. (M.C.G.)

For abstract of individual papers see: 2211.

Natural Radioactivity and Fallout

Refer also to abstracts 1575 and 1954.

1899 (TID-19559) RADIOACTIVITY TRANSPORT IN WATER—TRANSPORT OF STRONTIUM AND CESIUM BY STREAM AND ESTUARINE SEDIMENTS. Technical Report No. 1. T. D. Reynolds and E. F. Gloyna (Texas. Univ., Austin. Environmental Health Engineering Research Lab.). June 1, 1963. Contract AT(11-1)-490. 134p.

Factors involved in the transport of radioisotopes of Sr and Cs by suspended and bottom sediments in fresh water streams, lakes, and estuaries were investigated in watersheds of Texas and San Antonio Bay. An evaluation

of the distribution coefficients and mass action constants for Cs^{137} and Sr^{89} was based on observed data from laboratory and field studies. Uptake and release data for Ru^{103}, Cr^{51}, Fe^{59}, and I^{131} were also collected. The bodies of water selected were the Guadalupe River, Lake Austin on the Colorado River, Lake Falcon on the Rio Grande River, and San Antonio Bay. These sampling areas provided a variety of geographical and environmental factors. Although some uranium deposits are found in the watershed, the major portion of the radioactivity in the surface waters resulted from fallout and washout of radionuclides after nuclear detonations. Results showed that the transport of Sr^{89} and Cs^{137} in fresh water systems can be predicted, that their uptake by river and lake sediments is primarily an ion exchange process, that the mass action coefficients are relatively constant provided the K concentration in the solution did not vary appreciably, that the concentration of Sr^{89} and Cs^{137} in the sediments were relatively uniform throughout the fresh water reaches of the Guadalupe River, that sediments from San Antonio Bay contain lesser concentrations of Sr^{89} and Cs^{137} than the river sediments, that monovalent cations were more inhibitive to Cs^{137} uptake while divalent cations were inhibitive to Sr^{89} uptake, and the coarse-grained materials were significant in the uptake of Cs^{137} and Sr^{89} because of incrusted clay particles on the surface of the sand or gravel materials. (C.H.)

1900 DIRAC'S COSMOLOGY AND RADIOACTIVE DATING. E. R. Kanasewich and J. C. Savage (Univ. of British Columbia, Vancouver). Can. J. Phys., 41: 1911-23(Nov. 1963).

It has long been recognized that Dirac's principle might imply that the rate of β decay would vary with the age of the universe. If so, the radioactive ages of meteorites and terrestrial rocks as indicated on the one hand by α decay and on the other by β decay should differ. However, the comparison of these ages is complicated by a large uncertainty in the decay constant for Rb^{87}. Thus the age data must be analyzed to determine the decay constant most compatible with the particular theory of β decay that is used. Using this best decay constant for each theory, it is found that the data are more consistent with a β decay rate independent of the age of the universe than with the dependence implied by the Dirac principle. (auth)

1901 Sr^{90} CONCENTRATION IN PRECIPITATION FROM CONVECTIVE SHOWERS. P. Kruger and C. L. Hosler. J. Appl. Meteorol., 2: 379-89(June 1963).

Analysis was made of seven spring and summer convective showers collected at State College, Pa. The data indicate that the ground level Sr^{90} concentration in the precipitation is dependent upon the extent of the vertical development of the clouds from which the precipitation originates, and the distance of these from the jet stream. These data are contrasted to the data obtained from precipitation resulting from large-scale uplift where the generating level is essentially constant, and the ground level Sr^{90} concentration has been shown to be dependent upon the descent experience of the precipitation in falling from the cloud to the ground. (auth)

1902 STUDY OF THE RADIOACTIVITY OF HOKUTOLITE. Hiroshi Hamaguchi, Yuan-Tseh Lee, and Hwa-Sheng Cheng (Tokyo Univ.). J. Chinese Chem. Soc. (Taiwan), 9: 1-13(Mar. 1962).

Radioactive constituents and equilibria in the hot spring sediment Hokutolite were studied by determination of the activity ratio of U series to Th series. Investigation of natural radioactivity of the Hokutolite was examined in three portions, i.e., the Pb portion, Bi portion, and hydroxide portion. The various nuclides present in different portions were identified by following the growth and decay curves of the radioactivity of each portion. These three portions of Hokutolite were separated by either of two outlined procedures. For quantitative study the radioactive elements of the U series were determined by the absolute counting of Bi^{210} and that of the Th series by absolute counting of Ac^{228}. Since the β-ray energies of Ac^{228} and Bi^{210} are almost the same (1.11 and 1.17 Mev respectively), activities of both nuclides were determined by the constant geometry method, using Bi^{210} as the reference source for β rays. Activities of the Bi and hydroxide portions were measured in hydroxide form. By analyzing the time-activity curves it was possible to calculate the activity of Bi^{212} at time (T) = 0 to be ~150 cpm (if Bi^{212} is not separated from Pb^{212} at T = 0) and the saturation activity of Bi^{210} is about 390 cpm. Since the half life of Pb^{210} is very long (11 yr), the saturation activity of Bi^{210} would be about the same as that of Pb^{210} at T = 0, if it were not separated from Pb^{210}. Therefore, the apparent activity ratio of U series to Th series is 380/150 = 2.5. In the hydroxide portion the activity decayed with a half life of 6 hr to zero, and no other activity growth was observed afterwards. The only radioactive nuclide with a half life of 6 hr is Ac^{228}, which enables determination of the activity of Th series by the simple determination of Ac^{228}. In the Bi portion the analysis of the decay curve showed that it is composed of two nuclides with half lives of 1 hr and 5 days; therefore, Bi^{212} and Bi^{210} must be present. The activity of Bi^{210} at T = 0 was obtained by extrapolation of the analyzed decay curve of Bi^{210}. Quantitative analysis of M_2O_3 from the hydroxide portion showed that the M_2O_3 content is 2.56%; thus, there is 76.8 mg of M_2O_3 in 3 g of Hokutolite. Similarly, the Ra^{228} content is 0.16×10^{-13} g/g Hokutolite. Since the activity of the hydroxide portion decayed in a simple fashion with a half life of 6 hr, and no other activity growth was observed, U and Th are absent from Hokutolite. Otherwise the activities due to U and Th together with their daughters should be observed in the hydroxide portion. Thus, it is concluded that there are no equilibria between U^{238} and Ra^{226}, between U^{235} and Ra^{223}, or between Th^{232} and Ra^{228}. The radioactive equilibrium originates from Ra, as is supported by the presence of Ac^{228}, the daughter of Ra^{228}. Since the radioactive series in Hokutolite originates from Ra, the presence of Ra^{226}(1622 yr), Ra^{228}(6.7 yr), and Ra^{223}(11.1 days) can be predicted. Since Ra^{223} has a very short half life as compared with the history of the formation of Hokutolite, it is believed that if there had been any Ac series in hot spring water and in Hokutolite, their activity would have been exhausted in Hokutolite. (BBB)

1903 SYSTEMATIC INSPECTION OF THE RADIOACTIVITY OF THE SEA ALONG THE COAST OF ITALY. ARRANGEMENT OF THE NETWORK FOR WITHDRAWAL OF SAMPLES OF WATER AND SEA FAUNA. TECHNIQUES AND DATE OF THE MEASUREMENTS. PROGRAM OF STUDY AND RESEARCH. L. Argiero, G. Del Corso, S. Manfredini, and G. Palmas (C.A.M.E.N., Pisa, Italy). Minerva Nucl., 7: 261-7(July 1963). (In Italian)

In view of the future development of the applications of nuclear energy and the possibility of sea contamination, a systematic series of measurements of the radioactivity in the sea and marine fauna is being carried out. The seawater sampling network consists of thirteen sampling stations spaced at suitable intervals along the Italian coastline. The marine fauna control network consists of

six sampling stations in the same sites as six of the water sampling stations. A research plan was drawn up to determine, on the basis of oceanographic data, the fate of radioactive waste in the sea. (auth)

1904 SURVEY OF RADIOACTIVE FALLOUT. SUMMARY REPORT (1961-1962). Tai Soon Kim, Hyo Hoom Han, and Hack Pill Chung. Rept. Army Res. Testing Lab., 1: 79-84(1962). (In Korean)

Total β radioactivity in rainwater and dry deposition were measured to assess fallout deposited in the Seoul area. Since nuclear tests resumed in 1961, radioactivity was rapidly increased from the middle of September 1961 to the end of 1962. Total fallout deposition was 338.8 mC/km^2 in 1961 and 859.9 mC/km^2 in 1962. (auth)

1905 TRITIUM DISTRIBUTION IN GROUND WATER AROUND LARGE UNDERGROUND FUSION EXPLOSIONS. Frank W. Stead (Geological Survey, Denver). Science, 142: 1163-5(Nov. 29, 1963). (TID-18853)

Tritium will be released in significant amounts from large underground nuclear fusion explosions in the Plowshare Program. The tritium could become highly concentrated in nearby ground waters, and could be of equal or more importance as a possible contaminant than other long-lived fission-product and induced radionuclides. Behavior of tritiated water in particular hydrologic and geologic environments, as illustrated by hypothetical explosions in dolomite and tuff, are evaluated to predict under what conditions high ground-water concentrations of tritium might occur. (auth)

1906 THE RADIOISOTOPIC DETERMINATION OF DIFFUSION COEFFICIENTS AND CURRENTS IN NATURAL WATERS. SURFACE COLLECTION OF RADIOACTIVE FALL-OUT ON A LARGE ALPINE LAKE. R. Chesselet (Centre d'Etudes Nucleaires, Saclay, France), D. Nordemann, and B. Dussart. p.63-75 of "Radioisotopes in Hydrology." Vienna, International Atomic Energy Agency, 1963. (In French)

In an initial stage, the in situ diffusion of a radioactive emitter (sodium-22, in the form of Na^+) with very low activity, less than 1 mC, was brought about. The diffusion laws applied in this case made it easy to predict the rate of diffusing of the radioactive cloud. In this way, plotting the activities, as measured by two suitably placed gamma detectors, against time permits the estimation of a diffusion coefficient for the emitter used and, if appropriate, the measurement of current velocity at the point of measurement (in the case described, the Lake of Geneva). Subsequently, and in conjunction with a geophysical study on the general problem of radioactive fallout, studies were made on the increases in radioactive fallout caused by nuclear tests in the atmosphere (October 1961–January 1962). Measurements of radioactivity were made every day on samples of Lake Geneva water taken at depths of 0, 10, and 20 m and also on a collector of dry and moist atmospheric fallout. Despite the complex pattern, over a period, of the increases in fallout, the interpretation of the diagrams obtained can help to explain what happens to radioactive products in the diffusion and current conditions encountered. The use of the diffusion of radioactive products in very small quantities and of the various highly sensitive techniques of nuclear detection now available can lead to a better understanding of in situ diffusion and of the movement of natural water masses. (auth)

1907 A SURVEY OF THE NATURAL ISOTOPES OF WATER IN SOUTH AFRICA. J. C. Vogel (Rijksuniversiteit, Groningen, Netherlands), D. Ehhalt, and W. Roether. p.407-15 of "Radioisotopes in Hydrology." Vienna, International Atomic Energy Agency, 1963.

A preliminary survey of the isotopes in fresh water from South Africa was made. The semi-arid climatic conditions cause the isotopic composition of rain, river, and groundwater to differ considerably from that in Europe and the northern United States. Results show that evaporation markedly changes the isotope ratio of the precipitation. Discontinuous recharge of the groundwater supplies is probably responsible for the observed deviations in this reservoir. An understanding of the different factors made it seem justifiable to tackle the more specific hydrological problem of subterranean flow-rates with natural tritium. Samples from a series of wells at increasing distances from the catchment area all give ages >30 yr. (auth)

Site Survey and Selection

1908 STRATIGRAPHY AND STRUCTURE OF THE RAINIER AND USGS TUNNEL AREAS NEVADA TEST SITE. W. R. Hansen, R. W. Lemke, J. M. Cattermole, and A. B. Gibbons (Geological Survey, Washington, D. C.). Geological Survey Professional Paper 382-A. 1963. 49p. 7 drawings. (GPO)

The effects of underground explosions on the Rainier and USGS Tunnels were investigated. Rocks exposed in the Rainier Tunnel area include dolomites and limestones of the Nevada formation of Devonian age, various rhyolitic and quartz-latitic tuffs, and tuffaceous sandstones of the Oak Spring formation of Tertiary age, and various unconsolidated rubbly surficial deposits of Quaternary age. Parts of the Oak Spring formation seem to have been deposited by direct fallout from volcanic ash clouds supposedly into the standing waters of a large lake, parts by reworking of ash fall material by streams, and parts by huge hot ash flows. Some of the latter have produced welded tuffs, which occur at three stratigraphic horizons in Rainier Mesa. The nonwelded parts of the Oak Spring formation are characterized, for the most part, by rhythmically alternating intervals of well-bedded tuff and poorly bedded or massive tuff. Each bedded interval overlies a minor stratigraphic break, or diastem. Paleozoic rocks were folded, faulted, and eroded before the overlying Oak Spring formation was deposited. Folding and faulting also followed deposition of the Oak Spring formation, and may have occurred intermittently during its deposition. Over most of its outcrop area the Oak Spring formation is gently folded. A large broad synclinal fold underlies Rainier Mesa and adjoining areas; the axes of several smaller superimposed folds pass through the Rainier Tunnel area. Within the small USGS Tunnel area the dip is mainly in one direction, to the east or northeast. Abundant small normal faults in the USGS Tunnel area fall into two well-defined sets —one that tends northeast, dips northwest, and is upthrown on the southeast; the other that tends northwest, dips northeast, and is upthrown on the southwest. The pattern of two mutually opposed sets of normal faults suggests a west-to-east tensional condition in the earth's crust at the time of faulting. Faults are less abundant at the Rainier Tunnel area than at the USGS Tunnel area, but their relations are similar and their origin probably is the same. Joints are abundant at the USGS Tunnel area and form a well-defined pattern with a predominant northeast trend and a subsidiary northwest trend. Joints are relatively fewer at the Rainier Tunnel area, except in the welded tuffs where they are very abundant. (P.C.H.)

1909 PHYSICAL PROPERTIES AND MINERALOGY OF SELECTED SAMPLES OF THE SEDIMENTS FROM THE VICINITY OF THE BROOKHAVEN NATIONAL LABORATORY, LONG ISLAND, NEW YORK. George T. Faust (Geological Survey, Washington, D. C.). Geological Survey Bulletin 1156-B. 1963. 34p. (GPO)

Twelve samples of unconsolidated sediments were collected from portions of cores obtained from seven wells near Brookhaven National Laboratory, Long Island, New York. The samples were analyzed by mechanical, mineralogical, and cation-exchange methods. The results of the mechanical analyses are interpreted by means of comparison with standard compilations. The mineralogic methods used in the identification and semiquantitative estimation of the phases include optical, x-ray diffraction, differential thermal analysis, electron microscopy, and radioactive measurements. The cation-exchange capacities are explained in terms of the mineralogic compositions of the specimens. The results of the various techniques used were critically evaluated to determine the petrographic significance of the data on the heavy, micaceous, and clay minerals. (P.C.H.)

Techniques and Equipment

1910 (CEA-2330) LA PROSPECTION DE L'URANIUM PAR LE RADON. (Uranium Prospecting Using Radon). J. Pradel, F. Billard, J. Miribel, A. Gangloff, Y. Puybaraud, and G. Tayeb (France. Commissariat à l'Énergie Atomique. Centre d'Études Nucléaires, Saclay). 1963. 30p.

The Rn that diffuses in the ground and migrates in the atmosphere is a natural radioactive tracer. The study of its production can give useful information on the U content and structure of the rocks from which it comes. Numerous authors have therefore suggested that U deposits be prospected by means of this Rn. Three analytic methods that have been used successively include the method of accumulation in a hole, the method of instantaneous sampling in the ground, and the method of sampling by scanning. Only the last has proved interesting and has been the object of systematic studies. It consists in purging the measurement recipient with air drawn from the probe and in measuring the variations in activity with time and with the volume drawn up, using a portable apparatus producing scintillations in a sulfuretted flask. The first series of measurements made it possible to develop an apparatus (flow rate, hole depth, scintillating probe) and to distinguish between the activities of the thoron and of the Rn by making two measurements at an interval of 54 sec. A campaign of systematic sampling was then carried out. It made it possible to show the good reproducibility of the results obtained and the good agreement with conventional methods. This method is the best one for areas having large overlap. In the appendix the detector and its mode of use are briefly described, and the first results of an emanometric prospecting test in the Vendée mining division are given. (auth)

1911 RADIOISOTOPES IN HYDROLOGY. Proceedings of the Symposium on the Application of Radioisotopes in Hydrology held by the International Atomic Energy Agency in Tokyo, 5-9 March, 1963. (International Atomic Energy Agency, Vienna). Proceedings Series. August 1963. 469p. (STI/PUB/71). $9.00; 189s; 54s.stg; NF 36; DM 31.50(IAEA).

Twenty-seven articles are included; separate abstracts were prepared for 24. One article on the application of radioactive tracers in scientific groundwater hydrology was previously abstracted in NSA. The remaining two articles not abstracted include information on the measurement of river-bed variations during a flood and flow measurements carried out in France with radioactive tracers, using the total count method. (P.C.H.)

For abstracts of individual papers see: 1906, 1907, 1912, 1913, 1914, 1915, 1916, 1917, 1918, 1919, 1920, 1921, 1922, 1923, 1924, 1925, 1926, 1927, 1928, 1929, 1930, 1931, 1932, and 1933.

1912 A COMPARISON OF RADIOISOTOPE METHODS FOR RIVER FLOW MEASUREMENT. C. G. Clayton and D. B. Smith (Atomic Energy Research Establishment, Wantage, Berks, Eng.). p.1-24 of "Radioisotopes in Hydrology." Vienna, International Atomic Energy Agency, 1963.

Dilution, Continuous Sample and Total Count Methods were used in a comparative study of radiotracer methods of river flow measurement in the Aylburton Brook in Gloucestershire and the Usway Burn and Alwin Rivers in Northumberland. The three rivers are of differing geological character with flow rates varying between 2.5 l/s and 3 m^3/s. In all tracer methods of flow measurement the distance between the measuring point and the point at which the tracer is introduced should be great enough for complete lateral mixing to have occurred. On the other hand, it should not be so great that longitudinal dispersion is excessive or that tracer is lost by adsorption on the river bed. Dispersion depends on the hydraulic characteristics of the stream and is intrinsic to the method. Adsorption depends on the choice of tracer and on the geological nature of the river bed. From the latter point of view H^3 is ideal as it is not adsorbed; but it is difficult to measure, and its progress in the river cannot be followed directly. Other tracers are more convenient but they may be adsorbed. The degree of adsorption of Na^{24}, Br^{82} and P^{32} in the form of $NaHCO_3$, NH_4Br, and NaH_2PO_4 was studied by comparison of measurements at several points downstream of a common injection point and by introduction of tritiated water (HTO) simultaneously with each of the three tracers. It is shown that P^{32}, which was expected to undergo a high degree of chemisorption, is valueless as a tracer for river flow measurement when used without carrier although there is a significant decrease in error when it is used with carrier. Na^{24} and Br^{82} show no evidence of adsorption at distances much greater than that required to give lateral mixing although at a distance of over 660 m in the slowest-moving river there is some evidence of Na^{24} removal. Some observations of the degree of lateral and longitudinal dispersion that affect the general application of tracer techniques to river flow measurement are presented. It was concluded that all three methods can be used satisfactorily. The Continuous Sample Method is ultimately preferred as it gives the highest accuracy for the smallest quantity of tracer. (auth)

1913 APPARATUS FOR MEASURING THE RELATIVE VELOCITIES OF GROUND WATERS BY THE POINT DILUTION METHOD. J. Guizerix (Commissariat a l'Energie Atomique, Paris), G. Grandclement, B. Gaillard, and P. Ruby. p.25-35 of "Radioisotopes in Hydrology." Vienna, International Atomic Energy Agency, 1963. (In French)

Description is given of an apparatus developed to determine the relative velocities of ground water. The apparatus, which is intended for insertion in a piezometer,

enables the water of one section of the piezometer to be isolated. By means of a device controlled from the surface a radioactive (gamma-emitting) tracer can be injected into this section, and an agitator ensures that the solution can be homogenized at any time. The radioactive tracer is scanned by a gamma-radiation detector located at one end of the measurement section. A suitable collimation device prevents the detector from being affected by the tracer located outside the peizometer. Results obtained with the apparatus are discussed. (P.C.H.)

1914 USE OF RADIOISOTOPES FOR OPEN-CHANNEL FLOW MEASUREMENTS. L. O. Timblin, Jr. and A. J. Peterka (Bureau of Reclamation, Denver). p.37-61 of "Radioisotopes in Hydrology." Vienna, International Atomic Energy Agency, 1963.

Field measurements with radioisotopes in canals discharging up to 8000 ft^3/s were made. The conditions of the field measurements are described, and important observations were made relating the results to the use of methods for discharge measurements in rivers. The field tests were performed to study the general feasibility of the use of isotopes for discharge measurements in open channels and to investigate some of the important field problems. These include the field requirements for necessary transverse mixing of the isotopes with the flowing water; sorption of the isotopes by suspended sediments, channel flow surfaces and aquatic plants; and improvement of field procedures and equipment. Results of laboratory and field tests led to a proposed method for employing radioisotopes in river-discharge measurement to provide continuous or periodic discharge determinations. (P.C.H.)

1915 AN INVESTIGATION OF THE HYDRAULICS OF AN UNDERGROUND POOL WITH IODINE-131. D. B. Smith and W. E. Clark (Atomic Energy Research Establishment, Wantage, Berks, Eng.). p.77-88 of "Radioisotopes in Hydrology." Vienna, International Atomic Energy Agency, 1963.

Water movement in a natural underground pool, semi-tidal and partly saline, was investigated with a radioactive tracer. 50 mC of iodine-131 was rapidly mixed with the water in the pool at low tide, and the volume of the pool was established by the dilution technique to be 3075 m^3. Subsequent dilution resulting from tidal movement showed that the pool was part of a larger water system, and measurements permitted the throughput of tidal water and the dispersion of the tracer into adjoining parts of the system to be estimated. After the initial dispersion the pattern of the decreasing tracer concentration was followed for four days and permitted the fresh water throughput to be estimated at 26 m^3/h. (auth)

1916 A STUDY IN RIVER ENGINEERING BASED ON THE RESULTS OF FIELD MEASUREMENTS OF FLOW VELOCITIES WITH RADIOISOTOPES IN THE SORACHI RIVER, JAPAN. Masao Kato (Tokyo Univ.), Otomaru Sato, Yoshiku Morita, Minoru Kohama, and Nobuo Hayashi. p.89-110 of "Radioisotopes in Hydrology." Vienna, International Atomic Energy Agency, 1963.

Radioactive tracer experiments were made in the summer of 1961 on the Sorachi River from the Kanayama Dam site to the Akabira intake, ranging 90 km. The objective of the experiments was to obtain precise information on the flow times to each intake and the flow conditions of the water released from the dam. A radioactivity of about 60 mC of sodium-24 was introduced into the stream in each reach tested. The lower reaches from the dam were divided into five reaches, each of which was about 15 to 20 km in length, and the tests were carried out five times in turn from the lowest reach. The test procedure consisted in the direct measurement by underwater detector and in the periodic collection of one-liter samples. In the case of the former, detecting efficiency for sodium-24 was 29×10^8 counts/cm^3 per min/μC with $1\frac{3}{4}$-in. diameter × 1-in. NaI crystal. In the case of the latter, sodium-24 was caught by an ion-exchange column in a recovery of 95%. The results by the two detection methods were figured as concentration versus time flow-through curves, and the peaks of both curves coincided very well. With the aid of such a procedure, the maximum distance traced with 60 mC was found to be about 30 km. Then, based on the results obtained, a study from the standpoint of river engineering was made. That is, the flow time of released water for irrigation was calculated, checking the reliability of the flow time estimated by velocity measured with the current-meter method at a representative discharge observation station in each longitudinal flow section and by the flow time actually measured through fairly long reaches of each section, using radioisotopes. Next, the longitudinal diffusion co-efficients of tracers in the Sorachi River were calculated, finding that each longitudinal diffusion of tracers correlates to the sectional equivalent roughness of the river in each longitudinal section of the stream. (auth)

1917 METHODS FOR MEASURING SAND TRANSPORT USING RADIOACTIVE TRACERS. G. H. Lean and M. J. Crickmore (Dept. of Scientific and Industrial Research, Wallingford, Berks, Eng.). p.111-31 of "Radioisotopes in Hydrology." Vienna, International Atomic Energy Agency, 1963.

Experiments were performed in a flume with a rippled sand bed to compare the rate of movement of sand and glass particles of the same size and density. Several methods of measuring sand transport in the flume using radioactive tracers are described and compared. Two of the methods were investigated in a series of tests; the first, usually termed the space integration method, involves the measurement of the spatial distribution of particles from a strip of the bed after various times; the second, referred to as the time integration method, requires the measurement of the passage of the tracer in time at a station downstream. The methods were used to measure the velocity of several size fractions in a sand mixture. The practical difficulties of applying the methods to measurements in the field are briefly examined. (auth)

1918 RADIOACTIVE TRACER STUDY OF SEDIMENT TRANSPORTED IN ALLUVIAL RIVERS. J. E. Chabert (Laboratoire National d'Hydraulique, Chatou, France), P. Jaffry, G. Courtois, and R. Hours. p.133-42 of "Radioisotopes in Hydrology." Vienna, International Atomic Energy Agency, 1963. (In French)

Techniques and equipment for studying the movements of sediments in rivers by means of radioactive tracers were developed. Qualitative studies were concerned primarily with gathering information on the development of zones of transport in relation to liquid discharge, on the formation of bars, and on the rate of advance of dunes, either for checking the satisfactory geometric and kinetic similitude of transport phenomena in a scale model (calibrating phase) or for evaluating the possibilities of correcting a channel for purposes of navigation. With these tests in view, measurements were made on the Niger, in the Republic of Mali (both in the river itself and on a model), and on the Loire, in France. In rivers where the alluvium is formed mainly of coarse gravel and pebbles, labeling of the alluvium (pre-

viously classified according to diameter) makes it possible to determine the hydraulic parameters for the onset of entrainment as a function of diameter, to derive transport granulometry as a function of liquid discharge, and to calculate the sediment discharge by application of a transport formula. The method is relatively simple to use, but its accuracy is directly related to that of the transport formula used. It yielded excellent results for the Rhone. (P.C.H.)

1919 RADIOTRACER EXPERIMENTS ON LITTORAL DRIFT IN JAPAN. M. Kato (Tokyo Univ.), M. Homma, S. Sato, and S. Sakagishi. p.143-74 of "Radioisotopes in Hydrology." Vienna, International Atomic Energy Agency, 1963.

Experimental methods of the tracer technique for determining littoral drift are described: the preparation methods and the properties of the radioactive glass sand, the depositing methods and equipment for depositing the radiotracer at a definite point and as point-like as possible on the sea bed, the kinds and the characteristics of the under-water detectors used, the consideration of radiation protection, and some incidental tracer techniques in the field experiment. Next, some typical examples of the experimental results obtained are shown and discussed from the following standpoint of coastal engineering: the experiment on the Kashimanada Coast carried out as a preliminary investigation for the construction of the harbour; sand movement around the break-water of the Tomakomai Harbour now under construction; investigation of sand deposition in the Niigata Harbour basin; and the investigation of erosion of the coast in the western part of Niigata. In addition, the experiment for determination of the vertical distribution of radioactive sand in the sea bed, the model experiment in a wave channel in order to make clear modes of sand movement and an unexpected experimental obstacle because of accumulated fall-out on the bed of the estuary of Shinano River located at the Niigata Coast are described. (P.C.H.)

1920 THE PLACE OF ISOTOPE METHODS IN GROUNDWATER RESEARCH. Y. Harpaz (Tahal-Water Planning Inc., Tel Aviv, Israel), S. Mandel, J. R. Gat, and A. Nir. p.175-91 of "Radioisotopes in Hydrology." Vienna, International Atomic Energy Agency, 1963.

The hydrologist's approach to groundwater utilization is described in terms of a few basic hydrological characteristics, namely the occurrence and origin of water, the physical and chemical properties of the aquifer and the fluid, such as the permeability and porosity, etc., the direction and velocity of water flow, and its dispersion and mixing patterns. The methods used for the determination of the basic hydrological characteristics were then surveyed. A new classification of isotope tracing methods, more suitable for comparison with the classical methods of hydrogeology, is suggested. The place of various isotopic tracing methods in the scheme was analysed. Their present and potential capacities and short-comings are discussed. Their usefulness in providing short-cut solutions is stressed, and some examples are given. The isotope methods discussed are the use of stable isotope (hydrogen and oxygen) variations in water, the use of natural and bomb-produced tritium and C^{14}, as well as the use of locally injected radioisotopes. The distinctive features of isotope methods are stressed: their variety and sensitivity of detection, the time scale inherent in radioactive decay, the existence of isotopes of the elements of water, and their measurable separation in natural processes. The contribution to the determination of the hydraulic parameters was found to be rather limited but of more direct value for the measurement of movement characteristics. The characteristics related to the bodily movement of water particles can be evaluated only with the aid of isotopes. (auth)

1921 HYDROLOGIC PHENOMENA AFFECTING THE USE OF TRACERS IN TIMING GROUNDWATER FLOW. C. V. Thesis (Geological Survey, Washington, D. C.). p.193-206 of "Radioisotopes in Hydrology." Vienna, International Atomic Energy Agency, 1963.

Hydrologic principles affecting the interpretation of data from tracer experiments concerned with groundwater flow are discussed. Some published work on tracers is mentioned for the purpose of pointing out modifying hydrological principles. (P.C.H.)

1922 POSSIBLE UTILIZATION OF NITRONITROSYLRUTHENIUM COMPLEXES AS TRACERS IN HYDROLOGY. C. Gailledreau (Commissariat a l'Energie Atomique, Paris). p.231-5 of "Radioisotopes in Hydrology." Vienna, International Atomic Energy Agency, 1963. (In French)

The properties of Ru^{106} for use as tracer in hydrology are discussed. However, its half-life of about one year is in a range in which there are few radioisotopes that can be used as tracers. There are a great variety of complexes of Ru^{106}, the nitro-complexes of nitrosylruthenium being among the most stable. Percolation tests were made with nitronitrosylruthenium diluted in water from the mains, on columns of aquiterous sand and a very argillaceous soil. (P.C.H.)

1923 NEW EXPERIENCES WITH THE USE OF RADIOACTIVE ISOTOPES IN HYDROLOGY. H. Moser, F. Neumaier, and W. Rauert (Research Station for Radiohydrometry, Munich). p.283-95 of "Radioisotopes in Hydrology." Vienna, International Atomic Energy Agency, 1963.

The practical application of hydrologic methods is described. In particular, the use of radioactive tracers to determine the course and extent of seepage flow under, and downstream of, storage dams is discussed. (P.C.H.)

1924 A METHOD FOR THE ESTIMATION OF GROUNDWATER STRATIFICATION. S. Iwai and Y. Inoue (Kyoto Univ.). p.297-307 of "Radioisotopes in Hydrology." Vienna, International Atomic Energy Agency, 1963.

A method for the estimation of ground water stratification involving comparison of two breakthrough curves of radioisotopes injected into ground is presented. The method requires at least two wells, one for the injection well and the other for the observation well. Before radiotracers are applied to the wells, groundwater velocity and its vertical distribution is determined by the point dilution method. A radioactive tracer is added in the well casing, and its decay by dilution of groundwater is observed. The groundwater velocity at a certain depth can be estimated from the rate of dilution. Tritiated water and a radiocation such as Sr^{90} are injected in the injection well, and their breakthrough to the other well is observed for individual radioisotopes. Logs of the wells, vertical distribution of groundwater velocities, and tritiated water breakthrough gives the stratification of groundwater at and around the observation well. The relationship between arrival time of the peak of Sr^{90} breakthrough and tritiated water breakthrough is given as $t = [1 + (1-f/f)\rho k_d]\ T = K_f T$, where t is the arrival time of the Sr^{90} peak, T is the arrival time of the HTO peak, f is porosity of the formation, ρ is the density of the formation, k_d is the distribution coefficient, and K_f is the time transformation factor. k_d may be estimated from the core samples of wells. By comparison of

the ratio of the two arrival times of peak and K_f the stratification of groundwater in the vicinity of the two wells can be estimated. Additional observation wells may be used if necessary in order to obtain more precise estimation of groundwater stratification for a wider area. (auth)

1925 THE USE OF TRITIUM IN TRACING KARST GROUND-WATER IN GREECE. D. J. Burdon (United Nations Special Fund Groundwater Project, Greece), E. Ericksson, B. R. Payne, T. Papadimitropoulos, and N. Papakis. p.309-20 of "Radioisotopes in Hydrology." Vienna, International Atomic Energy Agency, 1963.

Tritiated water was used to determine possible interconnections between two sinkholes on the high plateau of Tripolis and a number of springs near the coast of the Peloponnese. The existence of two interconnections was demonstrated and the results were applied to the determination of transit times, flow rates, and groundwater storage. (auth)

1926 TWO USES OF BROMINE-82 IN UNDERGROUND HYDRODYNAMICS. B. Degot (Bureau de Recherches Géologiques et Minières, Paris), P. Ch. Leveque, G. Courtois, M. Gasnier, and G. Godar. p.321-46 of "Radioisotopes in Hydrology." Vienna, International Atomic Energy Agency, 1963. (In French)

The use of radioactive tracers in velocity measurements in aquifers is described. Measurements were carried out by injecting Br^{82}-labeled NH_4Br into a piezometer and then surveying the arrival of the activity in a neighboring shaft. The results obtained provide valuable clarification of the distribution of velocities in an alluvial formation and represent a contribution, based on standard means of detection, to the verification of Theis' law under conditions that depart appreciably from the basic assumptions. Another application of radioactive labeling of water with Br^{82}, concerns the localization of permeable strata or seams in a geological calcareous marl series, intended to support quay walls in a harbor basin. The tracer, after being forced into the formation by inactive water, was pumped back and then local and overall measurements of activity permitted estimation of the recovered fraction and precise localization of the zones of recharge. In both cases, the radioactive tracers represented the only means at present available for resolving the problems raised. (P.C.H.)

1927 FIELD AND LABORATORY TESTS OF CHROMIUM-51-EDTA AND TRITIUM WATER AS A DOUBLE TRACER FOR GROUNDWATER FLOW. G. Knutsson (Chalmers Tekniska Hogskola, Goteborg), K. Ljunggren, and H. G. Forsberg. p.347-63 of "Radioisotopes in Hydrology." Vienna, International Atomic Energy Agency, 1963.

A stable EDTA-complex of Cr^{51} (half-life 28 d) was developed and used together with tritium water to study groundwater flow. With the double tracer it was possibe to follow the groundwater flow by measurement of the gamma radiation from Cr^{51} directly in the field and thereby to reduce the number of water samples for precise laboratory assessment. By comparison of the measured activities of Cr^{51} and tritium it was possible to determine whether there was any retardation or loss of the chromium complex as a result of adsorption. Six field investigations, each of about two months' duration, were made in glacifluvial sand and gravel. The results show that the chromium complex is transported as rapidly as the tritium water is, even at low concentrations (0.01 ppm) of the complex. 17 field investigations of one to three months' duration with the double tracer were carried out in various till (moraine) soils for a study of certain hydrological problems. Laboratory tests with soil and water from the various areas of field investigations showed that the chromium complex does not hydrolyze at concentrations above 0.01 ppm. A number of investigations of groundwater flow through fissures and channels were also made. When the velocity of flow was assumed to be very high, Br^{82} as bromide ion or Rhodamine-B, a fluorescent organic dye, were used. EDTA-Cr^{51} and tritium water were, however, used when the velocity was considered low or when, as in karst, a great number of channels or large subterranean water magazines were presumed. (P.C.H.)

1928 INVESTIGATION OF THE MOVEMENT OF INFILTRATING ACIDIC HOT-SPRING WATER IN THE GROUND BY MEANS OF RADIOISOTOPES. A. Ariizumi and O. Kondo (Public Works Research Inst., Tokyo). p.365-81 of "Radioisotopes in Hydrology." Vienna, International Atomic Energy Agency, 1963.

Tamagawa hot spring in Akita Prefecture gushes hot water of 1 pH hydrochloric acid at some 140 l/s. This quantity flows into the River Tama with the result that the river has been hindered from any significant hydropower development thus far. For the purpose of mitigating the acidity of the river water, the hot spring water is carried away through channels and infiltrated into the soil of a mountainside for chemical neutralizing through seepage before flowing into the river. To select the sites where the water can infiltrate and to determine its distribution, studies were made with the aid of radioisotope tracers on the capacity and ability for neutralization by mountain soil and the mechanism of the process. Such radioisotopes as I^{131}, P^{32}, Rb^{86}, Co^{60}, and H^3 as tracers were poured into holes with carriers. The radioactivity of the water appeared in fissures of the river bed located over 200 m away from the input holes; this was measured and the movement of underground water was analyzed by using the time variation of radioactivity obtained. As a result, it was found that the radioactivity increased considerably at sporadic intervals, that several holes had connections to one fissure for water, that the creeping time ranged from 6 to 82 hr, that the radioactivity found was less than the input, that behaviors were different among the nuclides applied, and that the aging of the underground water course was noticeable. (auth)

1929 THE USE OF THE CARBON ISOTOPES IN GROUNDWATER STUDIES. J. C. Vogel (Rijksuniversiteit, Groningen, Netherlands) and D. Ehhalt. p.383-95 of "Radioisotopes in Hydrology." Vienna, International Atomic Energy Agency, 1963.

The bicarbonate in groundwater is dissolved in the upper layers of the soil by the action of biogenic carbon dioxide on limestone. As a result of this solution mechanism the bicarbonate in shallow groundwater appears to have a quite characteristic C^{13} and C^{14} content so that these isotopes can be used to study isotopic exchange with and storage times in the aquifer. These circumstances also make it possible to date fresh water carbonates precipitated from such water. Measurements on water from deeper levels indicate that low C^{14} concentrations are mainly a result of radioactive decay and thus give true residence times. Values of 10000 yr and more are not uncommon. Several samples from the Netherlands suggest a stagnant or slowly moving substratum overlain by a thin layer of young water. Oxygen-18 and deuterium measurements on dated groundwater give information on the isotope composition of the original precipitation. (auth)

1930 A COMPARISON OF CARBON-14 AND TRITIUM AGES OF GROUNDWATER. K. O. Muennich and W. Roether (Universitat, Heidelberg). p.397-406 of "Radioisotopes in Hydrology." Vienna, International Atomic Energy Agency, 1963.

Simultaneous measurements of C^{14} and tritium in groundwater samples from different horizons were undertaken. The aim was to find out whether there might be a decrease in C^{14} that exceeds the radioactive decay and could be attributed to exchange with the aquifer. A few measurements made so far of the same wells in different years show essentially no increase from bomb C^{14}. This might be attributed to a stratification of the decaying organic matter in the soil, so that the very latest material does not contribute appreciably to the solution of lime by the percolating water. (P.C.H.)

1931 THE RUNOFF OF FALL-OUT RADIOSTRONTIUM FROM A RIVER AND ITS APPLICATION IN HYDROLOGY. N. Yamagata (Inst. of Public Health, Tokyo), T. Okita, and K. Kodaira. p.417-23 of "Radioisotopes in Hydrology." Vienna, International Atomic Energy Agency, 1963.

Measurements were made of the concentration of Sr^{89} and Sr^{90} in river waters in May 1962. The difference of the radionuclides in their half lives (51 d for Sr^{89} and 28 yr for Sr^{90}) but identical chemical properties and the mechanisms by which they are supplied to land surface were considered to give some information on the pattern of water balance between precipitation and the runoff from the river. The ratio of Sr^{89} to Sr^{90} in the precipitation is a function of time if the series of nuclear bomb testings by the USSR is assumed a single shot in the autumn of 1961. The measured value of the ratio was approximately 15 in the precipitation at the time of river water sampling, whereas the ratios in the river water showed smaller values, at three stations downstream along the river Tonegawa, respectively 11, 8.1, and 7.9. The ratio of Sr^{89} to Sr^{90} in the cumulated ground deposits, which were originated from older debris, was approximately zero, because Sr^{89} decayed out of its short half life. Therefore, the lower values in the ratios in river water are explained by the mixing of the surface runoff of radiostrontium from the fresh debris and that from the older debris, which flows into the river by leaching with groundwater. (auth)

1932 ESTIMATION OF THE DIRECT CONTRIBUTION OF METEORIC WATER TO RIVER WATERS BY MEANS OF FALL-OUT RADIOCESIUM AND RADIOSTRONTIUM. Y. Miyake (Tokyo Kyoiku Univ. and Meteorological Research Inst., Tokyo) and H. Tsubota. p. 425-31 of "Radioisotopes in Hydrology." Vienna, International Atomic Energy Agency, 1963.

The ratio of direct contribution of meteoric water to river water using as radioactive tracers Cs^{137} and Sr^{90} in river water originating from fall-out was estimated. Ten representative rivers in Japan were chosen: Ishikari (Hokkaido), Mogami, Kitakami, Shinano, Tone, Kiso, Yodo, Asahi (Honshu), Yoshino (Shikoku), and Chikugo (Kyushu). Sampling of water was undertaken during the period from the end of July to early August 1961. The sampling site of each river was selected to avoid industrial contamination and inflowing sea water. Each 100-l sample was collected at three stations traversing a river. After adding a carrier of 100 mg each of stable cesium and strontium, water was passed through a cation exchange column (Dowex 50W-X8, 50-100 mesh, Na-form, 500 ml) to fix cesium and strontium in the resin. Cesium and strontium were eluted with a 5% solution of oxalic acid followed by 3 N hydrochloric acid, and they were determined in the latter fraction. Sr^{90} was separated by a fuming nitric acid method. Beta counting was done on its daughter, yttrium-90, after milking. Radiocesium was adsorbed on ammonium molybdophosphate followed by purification by means of passage through a type of phenol-sulphonic acid cation-exchange resin. Beta activity was measured in the form of perchlorate. The average value of Cs^{137} and Sr^{90} in the water of ten rivers was 0.035 and 0.2 pC/l, respectively, while those in meteoric water were 2 and 0.7 pC/l, respectively, at that time. Since Cs^{137}, which is one brought into contact with soil is difficult to remove, it may be said that most of the Cs^{137} in river water results from the direct pouring of rain water into rivers. Under this assumption, the direct contribution of meteoric water to river waters was found to be 1.7%. Using this value, the rate of leaching of Sr^{90} accumulated in the soil is on the order of 1.5%/yr. (auth)

1933 MEASUREMENT OF RIVER DILUTION AND FLOW BY MEANS OF RADIOACTIVE TRACERS AND ACTIVATION ANALYSIS. M. Kobayashi and A. Nukazawa (Tokyo Metropolitan Isotope Center). p.433-49 of "Radioisotopes in Hydrology." Vienna, International Atomic Energy Agency, 1963.

A method adopted to measure the velocity and the dilution rate of radioactive NaCl solution injected in a river as a point source and of non-active NaBr or NH_4Br solution injected continuously is described. Radioactive tracers acted as indicators of the arrival of non-active tracer chemicals at the observation stations downstream. One liter of NaCl solution containing 3 g of NaCl, whose total activity was 13.7 mC, was poured into the river first as a point source; this was followed by a continuous injection for 30 min of 70 l of NaBr solution, whose concentration was 13%. In the second tracer experiment 100 kg of NH_4Br was used as a non-active tracer to compare the effectiveness of Br^{80} and Br^{82}. Immediately after the completion of injection, one liter of radioactive NaCl solution was again added. By means of a water-tight scintillation counter immersed in the stream, the change of the activity downstream was recorded continuously. The dilution rates up to 10^5 and the mean flow velocity at each interval were obtained from the calibration of the measured values. The specific activities determined by radiometric analysis of the water samples showed good accordance with those obtained by the method mentioned above. A small portion (0.1-1 cm^3) of the water samples was irradiated for (3 min-6 hr) in a neutron flux of about 4×10^{11} n $cm^{-2}s^{-1}$. From the activities of Na^{24}, Br^{80}, or Br^{82} the dilution rates, which showed about one hundredth values of those in the case of the point-source method, were also determined. A method for tracing the constant injection of effluent water using as small an amount of radioactivity as possible was established. (P.C.H.)

1934 NEUTRON GENERATOR DISCHARGE APPARATUS. Philip Warren Martin and Stanley Grover Stroud. British Patent 941,687. Nov. 13, 1963. Filed Nov. 23, 1961.

A simplified, self-contained ion accelerator that uses deuterium–tritium reactions to produce 14-Mev neutrons, in pulses if desired, is described. The relatively high flux, lack of gamma rays, and monoenergetic nature of this neutron source permits direct hydrocarbon logging, continuous sodium logging, and general extension and facilitation of well logging. (D.C.W.)

Thorium and Uranium Minerals

1935 URANIUM DEPOSITS IN SWITZERLAND. Th. Huegi (Universität, Bern). Atomwirtschaft, 8: 524-9 (Oct. 1963). (In German)

Uranium prospecting in Switzerland is discussed. Various newly found indications of uranium deposits are distributed over the Pennine Zone, in particular the Kasannaschiefer and the Permotrias, the Central Massif, especially the Aar massif and the Tavetsch intermediate massif, the Bergell massif, the Helvetian zone and the Southern Alps. The deposits and the prospecting work are described. In the rest of Switzerland, only scattered relatively limited areas or typical profiles were radiometrically sampled, mainly in the central area and in the Jura mountains. Some of the Alpine uranium deposits are considered worth exploitation. Their scale and significance can, however, only be determined by large scale prospecting involving experimental tunneling and boring. The work necessary for the cataloging of uranium deposits in Switzerland is being continued. (auth)

1936 URANIUM IN CARBONATE ROCKS. Kenneth G. Bell (Geological Survey, Washington, D. C.). Geological Survey Professional Paper 474-A. 1963. 29p. (GPO)

Investigations of carbonate rocks, both in the field and in the laboratory showed that, whereas most rocks that have carbonate minerals as major primary constituents have very little or possibly no uranium, nevertheless certain classes of these rocks may contain above average quantities of uranium. The results of investigations on 70 samples of sedimentary carbonate rocks and carbonate source materials from various locations are tabulated. (P.C.H.)

HEALTH AND SAFETY

Refer also to abstract 1945.

1937 (AD-422046) SHOCK, VIBRATION AND ASSOCIATED ENVIRONMENTS PROTECTIVE CONSTRUCTION. PART II. Bulletin No. 32. (Office of the Director of Defense Research and Engineering, Washington, D. C.). Aug. 1963. 201p.

Eleven papers presented at a symposium held at Sandia Base, New Mexico, on April 15 to 18, 1963, are given on various topics related to direct induced effects and air blast effects. These topics include ground motion, crater scaling, underground structures, stress and shock wave propagation in soils, air blast reduction, and ground shock spectra. Separate abstracts were prepared for ten of the papers; the remaining paper was previously abstracted in NSA. (D.L.C.)

For abstracts of individual papers see: 1884, 1885, 1886, 1887, 2394, 2395, 2396, 2397, 2398, and 2399.

1938 (AEET/AM/35) DEPOSITION OF IODINE-131 FROM THE NUCLEAR WEAPON TESTS IN THE PACIFIC DURING 1962. S. J. S. Anand and K. G. Vohra (India. Atomic Energy Establishment, Trombay). 1963. 9p.

Iodine-131 is produced in nuclear weapon tests as a fission-product. This report contains the results of measurements of iodine-131 in rainwater and milk for the period between June and August 1962. Data on the deposition of iodine-131 on the ground are also included. The measurements represent the levels of iodine-131 in the environment after the Pacific Tests which started on April 25, 1962. Brief description of the chemical procedure used for the separation of iodine-131 from rainwater and milk, and the method of counting are also included in this report. The present work is only preliminary to the large scale measurements of iodine-131 in the environments whenever the situation demands and the emphasis was more on the perfection of chemical and counting methods than on the collection of data. (auth)

1939 (AEET/AM/36) AIRBORNE CERIUM-141 AND CERIUM-144 AT BOMBAY DURING NOVEMBER 1961 – FEBRUARY 1963. L. U. Joshi and K. G. Vohra (India. Atomic Energy Establishment, Trombay). Aug. 1963. 17p.

Chemical separation of cerium from airborne fallout samples was carried out to determine cerium-141 and cerium-144 activities in air. The levels of cerium-141 and cerium-144 activities for the monthly air-filter samples collected at Bombay during the period November 1961 to February 1963 were measured and the ratios Ce-141/Ce-144 were calculated. Higher levels of cerium-141 were observed in June 1962 and during October 1962 to February 1963, while high cerium-144 levels were observed from December 1961 to April 1962 and during January and February 1963. A sharp increase in the ratio of cerium-141 to cerium-144 was observed in June, August, October, and December 1962 indicating the arrival of fresh radioactive debris in the atmosphere from the tests carried out during 1962. This report gives the method of sampling, chemical procedures and the data on the levels of cerium-141 and cerium-144 in the ground level air. (auth)

1940 (AERE-R-4249) THE EFFECT OF PARTICLE SIZE AND DUST LOADING ON THE SHAPE OF ALPHA PULSE-HEIGHT SPECTRA OF AIR SAMPLE FILTERS. D. C. Stevens and A. E. R. Toureau (United Kingdom Atomic Energy Authority. Research Group. Atomic Energy Research Establishment, Harwell, Berks, England). Sept. 1963. 21p.

The effects of particle size and total dust loading on the shape of alpha pulse height spectra obtained by direct measurement of dust collected on membrane filters (Millipore), glass fibre filters (Whatman AGF/A), and cellulose fibre filters (Fourstones Sample A) were studied using uranyl acetate and uranium oxide aerosols. Large active particles of diameter comparable with the range of the alpha emission in the particles ($\sim 5\mu$ for uranium oxide) are the most serious cause of alpha energy degradation and result in almost complete loss of resolution. The alpha pulse-height spectra from small dust particles ($\sim 1\mu$) collected on membrane filters are comparable with that obtained from a standard 'thin' source. When glass fibre filters are used, some broadening of the peaks of the spectra occurs due to the penetration of the particles into the surface fibres but this is not excessive and it is generally possible to identify the commonly occurring nuclides. A large proportion (50 to 80%) of the alpha emission from fine dust particles is completely absorbed in the fibres of the cellulose filters but the quality of the pulse height spectra obtained is similar to that obtained with glass fibre filters. Resolution is not seriously reduced by the presence of inactive dust on membrane or glass fibre filters until the dust loading is about 0.4 mg/cm^2. (auth)

1941 (BNL-807) 1962 ENVIRONMENTAL RADIATION LEVELS AT BROOKHAVEN NATIONAL LABORATORY. A. P. Hull (Brookhaven National Lab., Upton, N. Y.). May 1963. Contract AT-30-2-GEN-16. 14p.

Results are reported from measurements of natural background radiation levels during 1962 in the environs of Brookhaven National Laboratory. The contribution of laboratory operations, Ar^{41} content of the BGRR cooling-air effluent, an ecology field γ source, the discharge of low-level liquid wastes, and fallout to radiation levels were measured. Radiation levels attributable to laboratory operations were well below the established permissible levels. (C.H.)

1942 (CEA-2231) SPECTROGRAPHIE GAMMA À GRANDE SENSIBILITÉ POUR SOURCES ÉTENDUES. APPLICATION À LA MESURE DE L'ACTIVITE DU CORPS HUMAIN, DU VERRE ET DU SOL. (High-Sensitivity Gamma Spectroscopy for Extended Sources. Application to Activity Measurements on the Human Body, on Glass, and on Soil). Bernard Jouve (France. Commissariat à l'Énergie Atomique. Centre d'Études Nucléaires, Saclay). 1962. 107p.

Thesis submitted to Université, Paris.

The measurement and location by gamma spectroscopy of human body internal contaminations at maximum permissible levels, and, in certain cases, at lower activities such as that due to K^{40} was investigated. The characteristics of the high-sensitivity apparatus used are given, and several assemblies using large-volume NaI(Tl) scintillators are described. The relatively light shielding required for natural radioactivity permitted construction of a mobile assembly. Conditions of use are described, and the results are given. All gamma emitting elements were

measured in 15 min at levels lower than the tolerance dose. Gamma spectroscopy was also used to determine fission products in the earth and to study radioactive elements in the presence of other emitters. (auth)

1943 (CEA-2277) MESURES JOURNALIERES DE LA RADIOACTIVITE NATURELLE ET ARTIFICIELLE DANS L'AIR EN 1962. (Daily Measurements of Natural and Artificial Radioactivity in 1962). J. C. Philippot (France. Commissariat à l'Énergie Atomique Centre d'Études Nucléaires, Fontenay-aux-Roses). 1963. 31p.

Daily numerical results of measures concerning β activity of the air, either from natural, from thorium or from active aerosols, are presented. All results are expressed in $\mu\mu$curie/m^3 of air. (auth)

1944 (CEA-2311) PROTECTION DU PERSONNEL CONTRE LA CONTAMINATION ATMOSPHERIQUE PAR LE PLUTONIUM, DANS LES LABORATOIRES. (Protection of Personnel Against Atmospheric Contamination by Plutonium in the Laboratory). P. Feliers, J. Pomarola, and A. Risselin (France. Commissariat à l'Énergie Atomique. Centre d'Études Nucléaires, Fontenay-aux-Roses). 1963. 19p.

Various problems about measurement of atmospheric contamination by plutonium in laboratories are considered. In particular are studied sampling methods, continuous measurement for alarm, criteria used for fixation of the concentrations to be measured, sensitivity of apparatus, and effects of natural atmospheric contamination. The means actually available for measurement of contamination and their limits of use are briefly analyzed. (auth)

1945 (CEA-2323) ESSAI D'ETUDE DE LA CONTAMINATION DU CHEPTEL EN PERIODE DE RETOMBEES RADIOACTIVES. (Study of the Contamination of Livestock During Periods of Radioactive Fallout). G. Michon and L. Jeanmaire (France. Commissariat à l'Énergie Atomique. Centre d'Études Nucléaires, Fontenay-aux-Roses). 1963. 27p.

The contamination by fallout of a herd of grazing cattle, made up of 9 cows and 7 calves, was followed after the nuclear tests of 1961. Iodine-131 excreted in milk was found to be about 1% of daily intake. Only a few of the elements in mixed fission products were metabolized. One kilo of liver contained about 5×10^{-5} of the amount of Zr^{95}–Nb^{95} taken up per day, and about 4×10^{-4} of the daily intake of Ru^{106}. These elements were not found in muscle tissue. (C.H.)

1946 (CEX-61.6.3) ARMS II—CAMDEN-DELAWARE VALLEY AREA AERORADIOACTIVITY SURVEY. R. B. Guillou (Edgerton, Germeshausen and Grier, Inc., Santa Barbara, Calif.). Nov. 10, 1961. Contract AT(29-1)-1183. 29p. (S-62). 30p.

An aerial survey was made of the environmental levels of γ radiation of the Camden-Delaware Valley Area between Sept. 4 and Oct. 16, 1961. Parts of New Jersey, Pennsylvania, Delaware, and Maryland were included in the survey. The data are presented in aeroradioactivity units, or areas of similar γ radiation rates at 500 ft, at two map scales. Aerial measurements of radioactivity were consistent with those expected. (C.H.)

1947 (EUR-461.d,f,i,n) RESULTS OF THE RADIOACTIVITY MEASUREMENTS IN THE COMMUNITY COUNTRIES FOR THE YEARS 1961–1962. (European Atomic Energy Community). 157p.

Text appears in German, French, Italian, and Dutch.

The present document contains the results of the measurements made at a large number of posts responsible for the monitoring of background artificial radioactivity in the six Community countries. It is divided into three chapters dealing respectively with measurements of the air, fallout and surface waters for the years 1961 and 1962. Graphs showing the trend followed by results at a number of typical posts and for as extensive periods as possible. (auth)

1948 (HW-77609) HANFORD RADIOLOGICAL SCIENCES RESEARCH AND DEVELOPMENT ANNUAL REPORT FOR 1962. C. C. Gamertsfelder and J. K. Green, eds. (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Contract AT(45-1)-1350. 304p.

Separate abstracts were prepared for five sections of this report. (C.H.)

For abstracts of individual sections see: 1487, 2021, 2022, 2389, and 3388.

1949 (IDO-16925(p.41-8)) A SIX-MINUTE MATERIAL BALANCE REPORT. O. L. Meadors and K. O. Garcia (California. Univ., Livermore. Lawrence Radiation Lab.). (UCID-4610)

A fully integrated and operational automatic data processing system for SS material control and cost accounting is described. Reports, both internal and external, are generated on an IBM 1401 Computer. Machine production of transfer documents is described. Increased control, excellent flexibility, "on time" reports, and considerable savings in overall effort are listed as advantages of this system. (auth)

1950 (IDO-16925(p.101-9)) ACCOUNTING SYSTEMS AND INTERNAL AUDIT METHODS. Russell E. Weber (Division of Nuclear Materials Management, AEC).

Operations of accounting systems and internal audits are discussed. Basic considerations in the development of a suitable accounting system are described. Methods of the internal review of procedures and operations are reviewed. (M.C.G.)

1951 (IDO-16925(p.111-18)) AEC AUDIT OF SS STATIONS. Sheldon Kops (Chicago Operations Office, AEC).

The AEC audit of SS Stations is a general review or survey in order to arrive at an opinion of the fairness of the Station's reported inventories of SS material. This opinion is derived after an audit of the records, observation and test of the physical inventory, and review of the Station's measurement and statistical data. (auth)

1952 (JÜL-136-ST) UMWELTRADIOAKTIVITÄT DER KERNFORSCHUNGSANLAGE JÜLICH. Jahresberich 1962. (Environmental Radioactivity of the Nuclear Research Establishment Jülich. Annual Report, 1962). K. J. Vogt (Kernforschungsanlage, Jülich, Germany). Mar. 1963. 110p.

An increase in the level of radioactivity in the environment was observed in 1962. This was due to fission products from nuclear-weapon tests. Monthly averages in aerosols, precipitation, and surface waters are presented and compared with values for the years 1958 to 1961. Data are presented in tables and graphs. (M.C.G.)

1953 (NP-13261(p.297-320)) SAFE HANDLING OF URANIUM AND URANIUM ALLOYS. G. G. Eichholz (Canada. Dept. of Mines and Technical Surveys. Mines Branch).

The radiation and toxicity characteristics of uranium are summarized, and recommendations for the safe handling

of uranium and uranium-bearing materials are outlined. The legal aspects involved in the use of uranium are reviewed. Typical experimental values of the radiation levels involved during commercial and laboratory operations such as melting, pouring, hot forming, dry cutting or grinding, scarfing, and welding are presented and discussed. (auth)

1954 (NP-13309) DATA FROM RADIATION PROTECTION PROGRAMS. Volume 1, No. 10. (Canada. Dept. of National Health and Welfare. Radiation Protection Div., Ottawa). Oct. 1963. 63p.

Data are presented on the radioactivity due to fallout in samples of air, precipitation, surface water, and milk collected throughout Canada during October, 1963. Results are included from reactor environment monitoring and personnel monitoring programs. (C.H.)

1955 (SC-DC-3248) AEROSPACE NUCLEAR SAFETY GROUND TEST PROGRAM. J. L. Colp (Sandia Corp., Albuquerque, N. Mex.). [Sept. 1963]. Contract AT(29-1)-789. 20p. (CONF-311-1)

From American Nuclear Society Aerospace Nuclear Safety National Topical Meeting, Albuquerque, N. Mex., Oct. 1963.

The assessment (by ground testing) of effects of mechanical actions, thermal and chemical interactions, and nuclear reactions upon the safety of nuclear power sources that are intended for aerospace applications is discussed. Progress in general studies and in testing of SNAP-9A and -10A is reviewed. (T.F.H.)

1956 (SCPRI(RM)IX-1963) RAPPORT D'ACTIVITE, SEPTEMBRE 1963. (Report of Activities, September 1963). (France. Service Central de Protection contre les Rayonnements Ionisants, Paris). 23p.

The results of the radiological monitoring of the atmosphere, nuclear sites, rain water, the food chain, and sea water are briefly summarized and shown graphically and in tabular form. (J.S.R.)

1957 (TID-5360(Suppl. 4)) A SUMMARY OF INDUSTRIAL ACCIDENTS IN USAEC FACILITIES, 1961–1962. (Division of Operational Safety. Industrial Safety and Fire Protection Branch, AEC). 34p.

Information is presented on accidents and incidents occurring during 1961 and 1962 in plants owned and operated by the AEC. Revised reporting requirements established by the AEC in April 1962 are outlined. Data are summarized on radiation exposure of AEC contractor personnel, accidents involving radioactive materials, and accidents involving fatalities. (C.H.)

1958 (TID-16764(Suppl.1)) A SUMMARY OF INCIDENTS INVOLVING USAEC SHIPMENTS OF RADIOACTIVE MATERIAL, 1962. D. E. Patterson and A. Mehn (Division of Operational Safety, AEC). Nov. 1963. 44p.

Fourteen incidents (described) occurred in the transportation of radioactive materials in 1962. None of the four incidents involving radiation release resulted in any serious consequences or costly cleanup. (D.C.W.)

1959 (TID-19669) STATISTICAL ANALYSIS OF ENVIRONMENTAL GAMMA-RAY SCINTILLATION SPECTRA. Progress Report, January 1963 to September 1963. Anthony Liuzzi and Bernard Pasternack (New York Univ., New York. Medical Center and New York Univ., New York. Inst. of Industrial Medicine). Oct. 25, 1963. Contract AT(30-1)-3136. 51p.

Work accomplished on statistical analysis of environmental gamma-ray scintillation spectra is reviewed. The statistical method being applied is that of modified weighted least squares as described by Pasternak. The work performed includes information on data processing and computer program, test of method with prepared composite samples, evaluation of model adequacy, and application to various biological and environmental samples in uniform geometry. (auth)

1960 (USNRDL-TR-659) CIVIL DEFENSE UTILIZATION OF SHIPS AND BOATS. W. H. Van Horn and D. Freund (Naval Radiological Defense Lab., San Francisco). July 16, 1963. 244p. (AD-421043)

Various ways in which ships and boats might supplement the over-all civil defense program were investigated. Both merchant and reserve fleet ships were considered for the part they might play in a lifesaving, life-sustaining civil defense capacity. Data for two port cities were analyzed to obtain information on population distribution and shipping activity. Engineering feasibility studies were made of the use of ships as personnel shelters and the availability of ships' utilities for use by shore installations. The protection offered from nuclear fallout radiation was calculated for two classes of ships. It was concluded that ships and boats could provide evacuation or fallout-shelter facilities, or both, before or during a nuclear attack. For the postattack situation, ships could serve as headquarters, hospitals, living quarters, storehouses, and prime producers of electrical power and potable water. It is recommended that further studies be made of selected port cities to determine how ships and boats could best be used to supplement present civil defense capabilities of these cities. (auth)

1961 (FTD-TT-63-585) PROTECTION AGAINST RADIOACTIVE SUBSTANCES AND WAR GASES. F. I. Manets. Translation of p.1-88 from "Zashchita of Radioaktivnykh i Otravlyayushchikh Veshchestv" (a publication of the Publishing House of the Ministry of Military Defense, Moscow, 1962). 80p.

The properties of radioactive substances and gases used in radiological and chemical warfare are discussed. Rules are presented for the protection of soldiers during combat. The basic source of radioactive contamination under combat conditions is surface or atmospheric nuclear explosions, and the effects from shock waves, intense luminous radiation, ionizing radiations, heat, and radioactive contamination by fission products, U, or Pu are discussed. The effects of meteorological conditions on the degree of radioactive contamination is considered. A characteristic feature of war gases is their ability to penetrate into structures and to retain their harmful effects over long periods of time after their application. The pathological effects of the various types of war gases are summarized. Individual and group protection against radioactive substances and chemical warfare agents is discussed. The methods considered include gas masks, protective clothing, and shelters. Radiation and chemical reconnaissance of a contaminated location and methods for the decontamination of personnel and equipment are discussed. (C.H.)

1962 (FTD-TT-63-968(p.321-5)) ABSORBED DOSES OF COSMIC RADIATION RECEIVED BY A. G. NIKOLAYEV AND P. R. POPOVICH DURING THEIR TWIN ORBITAL FLIGHT. I. B. Keirim-Markus, N. A. Sergeeva (Sergeyeva), and L. N. Uspenskii (Uspenskiy). Translated from Kosmich. Issled., 1: No. 1, (July-Aug. 1963).

Dosimeters in the flight suits showed that the average tissue dose rate was 16 mrad/day and that it was appreciably greater during Titov's flight, while the bremsstrah-

lung dose rate decreased. The upper limit of the neutron flux in the cabin was estimated to be $\leq 30/cm^2$ sec. (D.C.W.)

1963 OCCUPATIONAL HEALTH AND AIR POLLUTION RESEARCH IN CANADA'S CHANGING ECONOMY. Morris Katz and W. L. Ball (Dept. of National Health and Welfare, Ottawa). Am. Ind. Hyg. Assoc. J., 24: 517-28 (Sept.-Oct. 1963).

Industrial expansion in Canada has, at the same time, raised the standard of living and created new health problems. Ionizing radiation is viewed as one of the health hazards arising as an outgrowth of the expanding economy. Sources of potential radiation hazard in Canada are fallout, radiography, industrially-used isotopes, and uranium mining. Safeguards adopted for each of the hazards are identified. (H.M.G.)

1964 RADIATION PROTECTION IN WORK WITH NATURAL URANIUM. S. Steeb (Max-Planck-Institut für Metallforschung, Stuttgart). Atompraxis, 9: 395-404(Oct. 1963). (In German)

The establishment of radioactive equilibrium in freshly purified uranium is discussed. From this, the conversion relationship between mass and activity was derived for the isotope mixture to be monitored. The toxicity of uranium and the quantities of uranium permissible in various types of laboratories is also discussed. It is then shown that the data given for natural uranium, U_1, UX_1, and U_2 in Appendix II of the German Radiation Protection Ordinance can be used to derive concentration values for UX_2, which could thus be included in the Ordinance. Maximum tolerance activities in air, water, and on the surface of living and non-living material, together with practical monitoring procedures, are also discussed. (auth)

1965 ACTIVITY AND PERSONAL MONITORING IN THE EXPERIMENTAL POWER PLANT AT KAHL. G. Knoerzer (Versuchsatomkraftwerk, Kahl/Main, Ger.). Atompraxis, 9: 415-23(Oct. 1963). (In German)

If the Kahl power plant is operated at maximum output, the local dose outputs in the accessible parts of the reactor building are determined mainly by the flow of medium-fast neutrons with energies of 0.01 to 0.3 Mev. If operation is ceased, dose outputs of more than 100 mrem/hr appear only on the surface of the strongly contaminated valves of the cleaning circuit. Change of fuel elements, inspection of control rods, and all repairs made on parts of the primary circuit require extensive protection and monitoring measures in order to ensure that there is no contamination of persons or excessively high personal doses. The quantities of gaseous, liquid, and solid activity that are released to the outside are far below the maximum permissible level, since up to now there have been no leaks in the zirconium jackets of any of the 3168 fuel rods. (auth)

1966 DEEP DOSE AND COLLATERAL DOSE LOSS AT RADIATIONS OF VARIOUS HOMOGENEITIES. F. Wachsmann and R. Jaschke (Universität, Erlangen-Nuremberg). Biophysik, 1: 108-13(1963). (In German)

It was established through phantom measurements that with an increase of the field size over 400 cm^2 no measurable elevation of the relative deep dose results with 1 mm Al half value layer and with 1 mm Cu half value layer only a very slight elevation. Details on the size of the scattered radiation for fields of 100 and 900 cm^2, measured at the phantom surface and at 10 cm depth, were reported. The half value layer is sufficient to characterize the deep dose loss and the scattering radiation since the degree of homogeneity has only a very small effect on both these parameters. An extensive analysis of the radiation intensity curves for the primary radiation bundle and for the scattering radiation mantle as a function of the radiation hardness must still be made. (tr-auth)

1967 PERMISSIBLE CONCENTRATIONS OF RADIOACTIVE FISSION PRODUCTS IN AIR, DRINKING WATER, AND FOOD FOR THE GENERAL POPULATION. Th. Franke (Max-Planck-Institut für Biophysik, Frankfurt am Main). Biophysik, 1: 123-34(1963). (In German)

The permissible concentrations of radioactive fission products in air and water were determined, using as a basis the concentrations of radioactive nuclides in air and water judged permissible by the International Commission on Radiological Protection. The calculations were carried out for the following critical organs: the whole body, bones, gastrointestinal tract, and lungs. The neutron-induced radioisotopes and the isotopes of bomb materials present in fallout were considered. Under consideration of the contamination of the biosphere arising as a result of nuclear test explosions and the resulting radiation effects on man, permissible concentrations of radioactive fallout products in air, drinking water, and the principal foods were given. (tr-auth)

1968 RADIATION DOSE TO THE HUMAN INTESTINAL TRACT FROM INTERNAL EMITTERS. R. L. Hayes, J. E. Carlton, and W. R. Butler, Jr. (Oak Ridge Inst. of Nuclear Studies, Tenn.). Health Phys., 9: 915-20(Sept. 1963).

International (ICRP) recommendations for maximum permissible concentration of various radionuclides in water and air are based on a Standard Man model of average behavior. Previous work with animals has shown a high degree of variation among subjects where the intestinal tract was the critical organ. Estimations of dose to the lower large intestine were made on 54 human subjects. The variation in this group was extensive, although the average experience was roughly equal to Standard Man behavior. Age appears to have little effect on dose. The mode of dose ingestion (with meals or between meals) appears to have a decided effect on the dose received. (auth)

1969 RADIOISOTOPES IN THE 1962 DIET. Irving Michelson (Consumers Union of U. S., Inc., Mount Vernon, N. Y.). Health Phys., 9: 944-50(Sept. 1963).

Determinations were made of the content of Sr^{90}, Sr^{89}, Cs^{137}, and stable Ca in samples of typical diets of teenagers in 30 widely scattered locations throughout the U. S. during 1962. Data are tabulated and are compared with data on the diet of infants during the same period. The contributions of wheat and milk to radioactivity of the diets are discussed. (C.H.)

1970 MAXIMUM PERMISSIBLE LEVELS OF CONTAMINATIONS. R. Oliver (Churchill Hospital, Oxford). Health Phys., 9: 951-2(Sept. 1963).

Maximum permissible levels of radioactive contamination in Great Britain are discussed from the point of view of the practical health physicist. (C.H.)

1971 WATER UTILITY PLANNING FOR NUCLEAR ATTACK. Claud R. Erickson. J. Am. Water Works Assoc., 55: 1237-49(Oct. 1963).

In view of the amount of money and effort that the federal government is putting into these warning and detection systems, it would seem illogical for people at state and local levels to give only passive support to civil defense. American Water Works Association (AWWA) Committee on Radioactivity and Civil Defense, acting in an advisory capacity to the Secretary of Defense, has prepared an outline for a

manual on Radioactivity and Civil Defense for Water Utilities. This outline has been accepted by Office of Civil Defense (OD), which is having the manual written under an OCD contract. Inasmuch as the threat of a nuclear war may persist for generations, planning should transcend individual feelings on the merits of such planning. Civil defense is not confined to a government organization that is going to operate out of Washington after an attack; rather, civil defense depends upon each individual. To make it feasible, the individual has to do all the work. (auth)

1972 THE RADIOACTIVE FALLOUT IN THE REGION OF ISPRA DUE TO NUCLEAR EXPLOSIONS DURING THE 5-YEAR PERIOD 1958–1962. A. Malvicini (Euratom and Centro Comune di Ricerche, Ispra, Italy). Minerva Nucl., 7: 267-76(July 1963). (In Italian)

The values for radioactive fallout measured at Ispra during the period from 1958 to 1962 are reported. The percent values for the main radionuclides present in the mixture of fission products in the fallout in 1962 are also reported. (auth)

1973 PRESENTATION OF SOME FRENCH ACCOMPLISHMENTS IN THE DOMAIN OF INSTRUMENTATION APPLIED TO HEALTH PHYSICS. M. Dieval (Centre d'Etudes Nucléaires, Saclay, France). Minerva Nucl., 7: 276-87(July 1963). (In French)

A list of radioprotective apparatus, classified according to use, is presented, and the characteristics of some detectors which were recently constructed or which are being prepared, are described. (auth)

1974 INCREASE IN RADIOCARBON FROM THE MOST RECENT SERIES OF THERMONUCLEAR TESTS. Reidar Nydal (Norwegian Inst. of Tech., Trondheim, Norway). Nature, 200: 212-14(Oct. 19, 1963).

The recent increase in radiocarbon content of the troposphere and biosphere was investigated in order to obtain exact data on terrestrial C^{14} activity for estimating the human hazard and to examine transport processes in the atmosphere. A graph of the percentage increase (ΔC^{14}) in radiocarbon versus time shows a curve that is mainly the result of nuclear tests carried out in 1961 and 1962. The curve shows the typical seasonal variation, with increase in activity between Jan. and Aug. and a decrease the rest of the year. In Aug. 1963 a doubling of the normal C^{14} level in the troposphere was observed in high northern latitudes. In the last four months of 1963 a decrease in activity up to 10% is predicted because of the transfer of radiocarbon to the ocean and the southern hemisphere. It is also assumed that in the future the amount of C^{14} in the human population will rise to a maximum value, close to that of the final tropospheric level. (P.C.H.)

1975 γ SPECTROMETRIC AND RADIOCHEMICAL ANALYSIS OF FALLOUT SAMPLES FROM AUTUMN 1962. A. Kaul and U. Nay (Max-Planck-Institut für Biophysik, Frankfurt am Main). Naturwissenschaften, 50: 615-16 (1963). (In German)

Fallout samples were collected in planes flying at an average height of 10,000 m during the fall of 1962. The samples were analyzed by γ spectrometer before chemical separation and then they were analyzed radiochemically. No essential variations were found from the results obtained in the fall of 1961. Radiochemical analysis showed the presence of Sb^{125}, Nb^{95}, Ce^{144}, Pr^{144}, La^{140}, Mn^{54}, Cs^{137}, and Ba^{140}. (J.S.R.)

1976 THE MEASUREMENT OF ENVIRONMENTAL RADIOACTIVITY WITH SPECIAL REFERENCE TO WATER. D. I. Coomber. Proc. Soc. Water Treat. Exam., 12: 100-15(1963).

Radiological counting equipment used at the Laboratory of the Government Chemist in London is described, and measurement techniques for environmental radioactivity in water are discussed. Particular attention is given to radiostrontium determination in effluents; radioiodine, radium isotopes, and radon determinations in water; the use of carrier elements in water counting; the determination of fallout in tapwater; and tritium counting. (H.M.G.)

1977 SURVEY OF RADIOACTIVITY IN FOODS. Tai Soon Kim and Hack Pill Chung. Rept. Army Res. Testing Lab., 1: 85-6(1962). (In Korean)

At the present time, environmental radioactive contamination due to fallout presents serious radiological health problems to the human population. The contribution of radioactive materials from the diet represents a major internal radiation source of the human body; therefore, it is necessary to survey radioactive levels in various foods. The present paper deals with the total β-activity and Sr^{90} in foods purchased from the Seoul area during the period of past three years. (auth)

1978 ADEQUATE SHELTERS AND QUICK REACTION TO WARNING: A KEY TO CIVIL DEFENSE. Francis X. Lynch (Armed Forces Inst. of Pathology, Washington, D. C.). Science, 142: 665-7(Nov. 8, 1963).

Case histories collected by investigators in Japan during 1945 illustrate both the effectiveness of shelters and the dangers inherent in apathy of the population, which suffered needless casualities by ignoring air raid warnings. Adequate shelters and immediate response to warnings are essential to survival in nuclear attack. (auth)

1979 THE CONTROL OF TRITIUM HAZARDS AT NRU. W. T. Morecraft (Atomic Energy of Canada Ltd., Chalk River, Ont.). Trans. Am. Nucl. Soc., 6: Suppl., 26(Oct. 1963).

1980 FIBROUS FILTERS AS PARTICLE ANALYZERS. M. D. Silverman and W. E. Browning, Jr. (Oak Ridge National Lab., Tenn.). Trans. Am. Nucl. Soc., 6: 401(Nov. 1963).

1981 SAFETY. p.114-21 of "Isotopes and Radiation Technology. Vol. 1, No. 1."

The results of a radiation exposure survey of people working with radioisotopes are tabulated, and it is concluded that the risks to personnel are negligible compared to risks of everyday life. An examination was carried out on the stainless-steel capsule of a 9-year-old $Cs^{137}Cl$ source which had been used in a teletherapy machine since 1955, and the observation results are given. Results are also given of structural and fire-resistance tests of lead-filled casks and wooden fire and impact shields. (D.L.C.)

1982 RADIOLOGICAL HEALTH DATA [MONTHLY REPORT], VOLUME IV, NUMBER 10. (Public Health Service, Washington, D. C.). Oct. 1963. 60p. $0.50 (GPO). (RHD-Vol. IV, No. 10)

Data are presented on levels of radioactivity from fallout in samples of airborne particulates, precipitation, surface waters, milk, and food collected at various locations throughout the U.S., Canada, and other areas during 1962 and 1963. Results are included from measurements of I^{131} content in bovine thyroids collected between Jan. and July 1963 and estimates of stable Sr intake by residents of New York City, Chicago, and San Francisco in 1962. Environmental levels of radioactivity at Lawrence Radiation Laboratory in 1962 are included. Published data are summarized on nuclear detonations announced since Sept. 15, 1961. (C.H.)

1983 SHIELDED CONTAINERS (Engineering Materials). (Oak Ridge National Lab., Tenn.). (CAPE-1040).

Fourteen glossy prints are included: returnable container for solid materials; returnable gas shipping container; returnable container for liquid shipments; returnable container for solid materials; returnable gas container; gas ampoule; breaking break-off seals; returnable container for solid materials; special Co^{60} container; container for extra-hazardous materials; disposable container for solid materials; 2 disposable containers for liquid shipments; and adapter metal to glass. Dimensions and uses of the containers are given. (P.C.H.)

1984 SHIELDED COBALT CARRIER (Engineering Materials). (Oak Ridge National Lab., Tenn.). (CAPE-1054)

This package contains 2 drawings. The stainless steel carrier, known as the Notre Dame-type, is designed for use in conjunction with a specially arranged cobalt irradiator that is buried in the ground. The irradiator consists of a central cavity surrounded by tubes containing Co^{60}. The tubes of the carrier are loaded by first placing a lead slug in the bottom of the tube, then Co^{60}, and then another lead slug. To discharge the cobalt into the irradiator, the bottom plate is removed and the container is positioned over the irradiator. The container tubes are aligned with the irradiator tubes. Removal of a screw at the top of the tube to be emptied enables a rod to be inserted and screwed into the top part of the cobalt rod capsule. The indicator pointer aligns the discharge tube and the capsule is removed. The container is designed to take up to 5000 C of Co^{60}. It is 22 in. high, 21 in. in dia. and weighs 3300 lb. The lead shielding used is at least 5 in. thick. (F.S.)

1985 SAFETY OF RIFT VEHICLE LAUNCH AND FLIGHT OPERATIONS. R. C. Hock. 24p. (CONF-311-3)

From American Nuclear Society, Aerospace Nuclear Safety National Topical Meeting, Albuquerque, N. Mex., Oct. 1963.

The RIFT vehicle; typical RIFT trajectories, prelaunch, launch, and flight operations; and their related safety considerations are described. The potential hazards are subjected to only preliminary study. Data and analyses lead to the conclusion that the probability of a nuclear incident of any kind as a result of planned RIFT operation at Cape Canaveral is remote, and that the dangers involved should such an incident occur are acceptably low. (auth)

1986 EXPERIENCE ACQUIRED IN HEALTH PHYSICS AT SACLAY NUCLEAR RESEARCH ESTABLISHMENT. L. Fitoussi and H. Joffre. 19p. (CONF-67-32)

From Health Physics Society 8th Annual Meeting, New York, June 1963.

Description is given of the general organization and functions of the Health Physics Department of Saclay Nuclear Research Establishment. The means employed for the various installations covered and the general rules adopted for health physics are presented. From an overall survey of the results obtained in 1962, conclusions were drawn from past experience and to foresee improvements for the future are foreseen. (P.C.H.)

1987 ENVIRONMENTAL SAFETY ASPECTS OF ROCKET FLIGHT OPERATIONS. Morton I. Goldman and C. Rogers McCullough (Nuclear Utility Services, Inc., Washington, D. C.). 21p. (CONF-311-4)

From American Nuclear Society, Aerospace Nuclear Safety National Topical Meeting, Albuquerque, N. Mex., Oct. 1963.

The significant routes of radiation exposure that could occur with a nuclear rocket system that is unprotected by safety systems are described, and the effect of environmental parameters on the resulting doses. The approach considers the way in which material is released to the environment, and the identify of that segment of the environment in which the release takes place. For the study, launch site releases are assumed to fall into one of three environmental cases: a release to the atmosphere as a result of an inadvertent criticality occurring on or near the launch site from control rod malfunction, dropping and compacting of the core, and reflection by water; a release to the atmosphere from a nuclear excursion near the launch pad concurrent with the detonation of the booster propellant; and a release to the marine environment deriving from an early abort of the booster that results in the dropping of the nuclear stage into nearby waters. In examining cases occurring away from the launch site, other types of problems are revealed, particularly those resulting from premature reentry of radioactive fragments, or for that matter, of the reactor as a whole. (P.C.H.)

1988 SOME LIMITATIONS OF AVAILABLE RADIOACTIVITY STANDARDS. H. E. Kolde and G. J. Karches (Robert A. Taft Sanitary Engineering Center, Cincinnati). 16p. (CONF-67-33)

From Health Physics Society 8th Annual Meeting, New York, June 1963.

Difficulties encountered in the use of available radioactivity standards for the calibration of instruments, particularly for counting radionuclides found in the environment are discussed. The difficulties are caused by: inconsistencies among suppliers in reporting sources of error in the activity statement; failure of the supplier to indicate significant radioactive impurities; failure of some suppliers to furnish complete information on the standardization tecnnique and the assumptions concerning decay schemes and equilibrium conditions; and lack of convenient suppliers of standardized solutions of many radionuclides of interest. A model format for a radioactivity standard certificate is proposed. (auth)

INSTRUMENTATION

General

Refer also to abstracts 2403 and 3089.

1989 (AE-121) THE TRANSISTOR AS LOW LEVEL SWITCH. Anders Lydén (Aktiebolaget Atomenergi, Stockholm). Oct. 1963. 59p.

The common collector transistor switch has in the on state with open emitter a certain offset voltage $U_{EK} \approx -(kT/qB_N)$. This expression is derived in a more physical way. It is further shown at which emitter current the current amplification factor B_N should be measured to get a correct value for the above expression. The collector current I_K at zero collector voltage follows the equation $I_K = I_0[\exp(qU_E/kT)-1]$ extremely well. Substitution of I_{EBO} and I_{KBO} by I_0 in Eber's and Moll's relations consequently improves these equations, and the characteristics of the transistor switch can be better determined. At switching on and off transients appear across the switch. The influence of the "spike" at switching off can be described by a current I_{SPIKE}, which is easy to calculate. I_{SPIKE} is approximately dependent only on the base–emitter depletion layer capacitance and the chopper frequency f_0. Some compensated switches have lower drift than the drift in U_{EK}. They may, for example, have a temperature drift <0.2 μV/°C and a long time drift <2 μV/week. Some compensated switches also have $I_{SPIKE} < 10^{-12} \cdot f_0$ amp. The static offset current in the off state can easily be made $<10^{-12}$ amp. (auth)

1990 (PPAD-475D) FAST LINEAR GATING SYSTEM FOR SINGLE-CHANNEL OSCILLOSCOPE DISPLAY OF UP TO 21 SIMULTANEOUS PULSES. P. Stuber (Princeton–Pennsylvania Accelerator, Princeton, N. J.). Jan. 10, 1963. Contract AT(30-1)-2137. 16p.

Circuit design and performance data are given for a display system that accepts up to 21 simultaneous pulses in parallel and forms a train of pulses for display on a single channel scope. Representative pulses have: ~15 nsec widths at the base line, ~5 nsec rise times, and ~1 mamp peak current. (auth)

1991 (PPAD-480-D) SCALE OF TEN WITH ~10 NS RESOLVING TIME. P. Stuber (Princeton-Pennsylvania Accelerator, Princeton, N. J.). Feb. 19, 1963. Contract AT(30-1)-2137. 53p.

A fast decade scaler designed primarily for recording randomly spaced pulses is described. It consists essentially of 4 bistable multivibrators (using transistors in a saturated mode), arranged to count in a 1-2-4-8 natural binary code (a scale of 5 preceded by a scale of 2). The scales of 2 and 5 have resolving times of ~9 and ~20 ns, respectively. Estimates on expected counting errors for random input pulses are given. In addition to the actual decade scaler with visual decimal readout, a tunnel diode shaping circuit and a gating circuit are described. The nominal input current required for the shaping circuit is −5 ma into 50 ohms. The shaping circuit accepts pulses with risetimes from the nsec range to the msec range (amplitude dynamic range ~1:5) and standardizes them to a form acceptable by the scale of 2. (auth)

1992 (SC-TM-394-60(72)) A NEW MODE OF TRANSISTOR OPERATION. R. J. Gossett (Sandia Corp., Albuquerque, N. Mex.). Dec. 1960. Contract [AT(29-1)-789]. 11p.

Certain commercially available transistors can be operated in what appears to be a parametric mode in which the useful frequency range of the device can be extended from 100 to 200 times the normal alpha-cutoff frequency. An amplifier circuit was designed for use with low intermediate frequency transistors. The operation of the amplifier closely parallels that of the degenerate case for parametric diodes in that both input and output circuits are tuned to the signal frequency, while the feedback circuit is tuned to twice the signal frequency. In this configuration, power gains in excess of 40 db were measured at 400 mc using a 2-mc alpha-cutoff transistor. (auth)

1993 (TID-18355) A HIGH-SPEED TRANSISTOR AMPLIFIER. R. J. Epstein (Argonne National Lab., Ill.). Jan. 1963. Contract W-31-109-eng-38. 10p.

A non fed-back transistor amplifier with a gain of 10, rise and fall times less than 2.0 nsec, and the ability to deliver 5-v pulses into a 125 ohm load is described. The amplifier is non-inverting and accepts only positive pulses. However, a distributed inverting transformer is provided so that negative pulses may be amplified. The step function response is nearly monotonic. Pulse droop is less than 10% at a pulse width of 1 μsec. The estimated equivalent rms input noise is less than 50 μv over a bandwidth of 180 Mc/sec with lower half-power frequency ~160 kc/sec. (auth)

1994 (ZFK-PHA-6) DIE ZAHL DER ZUFÄLLIGEN KOINZIDENZEN BEIM ARBEITEN MIT EINER GEPULSTEN QUELLE. (The Number of Random Coincidences Working with a Pulsed Source). Juergen Moesner, Lajos Pöcs, and Josef Zimányi (Germany. Zentralinstitut für Kernphysik, Dresden). Dec. 1962. 12p.

By using simplified assumptions, relations are obtained to take into account the number of random coincidences for a fast-slow-coincidence arrangement operating with a pulsed source. It is shown that an effective resolving time τ' that depends on the properties of the source and the geometrical conditions can be defined. If the parameters determining τ' change during the measurements, it is necessary to get information about this change in order to determine τ'. (auth)

1995 PROCEEDINGS OF THE 2nd INTERNATIONAL MEASUREMENTS CONFERENCE, BUDAPEST; JUNE 26-JULY 1, 1961. Acta IMEKO (Intern. Messtech. Konf.), Budapest, 1961, 4: 1-560(1961). (Papers in Various Languages)

Instruments and methods for measuring thermal quantities and for physiochemical measurements are discussed in the 29 papers presented in this volume. Of the papers on physical chemistry, including photometry, spectroscopy, colorimetry, electrochemical measurements, and gas analysis, 4 were chosen for inclusion in NSA. (R.E.U.)

For abstracts of individual papers see: 1996, 2037, 2038, and 2039.

1996 FIVE-DECADE TRANSISTORIZED SELF-COMPENSATING IONIZATION VACUUM GAGE. Gy. Striker and K. Tarnay. Acta IMEKO (Intern. Messtech. Konf.), Budapest, 1961, 4: 315-29(1961).

The results of research for extending the possibilities of the method of filamentary modulation resulted in a new analysis of the mechanism of modulation and considerably increased modulation efficiency. Taking advantage of the

features of the Modion system, new and useful transistorized amplifiers and voltage and current stabilizing circuits were developed, resulting in a very small, compact, and reliable automatic vacuum-gage potentiometer, with special models extending into the ultrahigh vacuum range. (auth)

1997 THE INFLUENCE OF GAS FLOW CONDITIONS ON THE ACCURACY OF MASS-SPECTROMETRIC ANALYSIS OF GASEOUS SUBSTANCES. H. Birkenfeld. Acta IMEKO (Intern. Messtech. Konf.), Budapest, 1961, 5: 517-25(1961). (In German)

In consequence of the application of stable isotopes in research and techniques the importance of mass-spectrometric isotope analysis has also increased. In the determination of relative isotope distribution, gas flows slowly through the ion source. Molecules having different weights behave differently. Light molecules can flow more easily across inlet jets and heavy molecules remain longer in the ionizing space. The possibility is shown of eliminating the effect of the inlet jet. All the gas contained in the reserve tank is made to flow across the ion source, and isotope analyses are made at regular intervals. The reserve tank is enriched in heavier isotopes. This effect can be accounted for by the mean value of data obtained. The various dwelling periods of molecules with different weights in the ion source can be determined quantitatively by closing the inlet valve suddenly. This fact is accounted for in the evaluation. The error arising can be so high, especially in the case of light elements, that it cannot be neglected in exact isotope analysis. (auth)

1998 SOME ASPECTS OF THE PHYSICAL PRINCIPLES OF THE QUANTITATIVE ANALYSIS OF MASS SPECTROMETRY WITH THE PHOTOPLATE. H. Wagner. Acta IMEKO (Intern. Messtech. Konf.), Budapest, 1961, 5: 526-35(1961). (In German)

The photometric evaluation of photographic mass spectra for quantitative determination of different sorts of ions has gained in the last years on importance. It could be shown that in special cases (e.g., in solid-state analysis for the determination of admixtures with concentrations smaller than 10^{-6}) it is superior to the usual, but in most cases more accurate, mass-spectrometric methods. In this method the law of reciprocity for the blackening of a film by ions must be taken as valid, though this is questioned sometimes. Some research was made to clarify this, and it could be shown that for light and heavy ions and energies between 2.5 and 25 kev, using photoplates with very small gelatin content, no deviation of the reciprocity law could be detected. The measured grain-hitting efficiency and the theoretical evaluation of the blackening curves has shown that the blackening takes place in a single hitting process if the energy is higher than a limiting value, 20 kev by Hg^+, and this value is growing roughly proportionally with the square root of the mass of the ion. Under this limiting value a continuous transition takes place to many-hit processes. But even in this case, obviously at the small number of hittings necessary to produce the blackening of a single grain, unstable preceding processes of latent silver grains responsible for the reciprocity error do not come into action. Consequently, with plates with small gelatin content the reciprocity law must be looked upon as valid if the ion energies are of max 2.5 kev. (auth)

1999 PROCEEDINGS OF THE 2nd INTERNATIONAL MEASUREMENTS CONFERENCE, BUDAPEST, JUNE 26-JULY 1, 1961. Acta IMEKO (Intern. Messtech. Konf.), Budapest, 1961, 5: 1-771(1961). (Papers in Various Languages)

Instruments and methods for measuring electrical and magnetic quantities are presented in the 37 papers included in this volume. Radio engineering and radiation measurement techniques are included. Of the papers presented, only six (concerning radiation instrumentation and measurements and mass spectrometry) were chosen for NSA. (R.E.U.)

For abstracts of individual papers see: 1997, 1998, 2040, 2109, 2110, and 2784.

2000 A PROGRAMMED MULTI-CHANNEL NEUTRON DIFFRACTOMETER INSTALLATION. U. W. Arndt (Royal Institution, London) and B. T. M. Willis. Nucl. Instr. Methods, 24: 155-64(Aug. 1963).

The design features of the neutron diffractometer installation are described. An order code, which permits a large range of scattering experiments to be carried out under automatic control, is provided. It is possible to set up to sixteen shafts, which are shared between a number of independent instruments. The standard instrument is a four-circle diffractometer. (auth)

2001 SECONDARY ELECTRON EMISSION FROM ALUMINIUM FOILS IN HIGH ENERGY BEAM MONITORS. B. Planskoy (St. Bartholomew's Hospital, London). Nucl. Instr., Methods, 24: 172-80(Aug. 1963).

The secondary electron emission from an aluminum foil system used for monitoring high-energy electron beams is investigated. The 15-Mev primary electrons pass through a sandwich consisting of a target foil placed symmetrically between two guard foils, whose potential with respect to the target is varied. Saturation yields are attained at guard foil voltages of ±25 v. The yield is shown to consist of a small component of secondary electrons with energies in the kev region, whose yield increases with foil thickness in accordance with calculation and of a component of secondary electrons having energies of a few ev, whose yield is shown to depend almost entirely on the state of the two thin aluminum oxide surface layers. The necessity for positive guard foil voltages in order to draw out the low energy secondary electrons and the hysteresis effect observed for the yield/guard foil voltage curves, are thought to be due to the building up of potential differences within the oxide. For the positive saturation yield the repeatability of measurement per foil is ±1% if no air is admitted and ±2½% with an occasionally greater drop, if air is admitted to the apparatus between measurements. The application of the results to high energy beam monitors is discussed. (auth)

2002 A TRANSISTORIZED PHOTOMULTIPLIER DYNODE VOLTAGE REGULATOR. A. Barna (Univ. of Chicago). Nucl. Instr. Methods, 24: 247-9(Aug. 1963).

The design of a transistorized dynode voltage regulator for the d-c stabilization of photomultiplier tubes is presented. The basic regulator elements are 12 cascade emitter followers driven by a 2 mamp resistor chain following the variable high voltage via three cascaded emitter followers and a divider chain. (C.E.S.)

2003 APPARATUS FOR OBSERVING PHASE TRANSITIONS OF INCANDESCENT MATERIALS. George N. Rupert (Los Alamos Scientific Lab., N. Mex.). Rev. Sci. Instr., 34: 1183-7(Nov. 1963). (LADC-5802)

The temperature–time curve of a cooling or heating incandescent material is displayed either on a cathode ray oscilloscope or a strip chart recorder. Temperatures at which phase transitions occur are seen as discontinuities

in the curves. The temperature-sensing device is a photomultiplier tube. The sample is heated in an eddy current concentrator by induced radio-frequency currents. Light from the sample is divided by a beam splitter between the phototube and an optical pyrometer which is used for temperature calibration. The temperature range displayed for a fixed starting temperature may be reduced for opposing the phototube's output voltage with an adjustable fixed voltage. Typical cooling curves are included. (auth)

2004 ANOMALOUS RESIDUAL CURRENTS IN THE ULTRAHIGH VACUUM USE OF BAYARD-ALPERT IONIZATION GAUGES. Thomas E. Hartman (Texas Instruments, Inc., Dallas). Rev. Sci. Instr., 34: 1190-5(Nov. 1963).

Anomalously high residual collector current was observed with a Bayard-Alpert ionization gage after the gage was exposed to a relatively high pressure gas which will chemisorb on the grid of the gage. The evidence indicates that the principal portion of the anomalous residual current results from the subsequent release of the adsorbed species as high velocity ions. A small fraction of the fast ion collide with the collector resulting in a positive charge flow from the grid to the collector which is pressure independent. The more strongly chemisorbed gases are found to replace those which have been previously adsorbed. Oxygen results in the largest and most persistent anomalous residual current. (auth)

2005 ION RESONANCE MASS SPECTROSCOPY USING MAGNETIC SCANNING. I. Brodie (Varian Associates, Palo Alto, Calif.). Rev. Sci. Instr., 34: 1271-2(Nov. 1963).

The use of the omegatron for residual gas analysis by the frequency scanning method is described. (R.E.U.)

2006 CALIBRATION OF SURFACE-ATTACHED THERMOCOUPLES ON A FLAT-PLATE FUEL ELEMENT BY ELECTRICAL ANALOGUE AND ANALYTICAL TECHNIQUES. J. H. Brindley (Atomics International, Canoga Park, Calif.). Trans. Am. Nucl. Soc., 6: 333-4(Nov. 1963).

2007 INVESTIGATION OF NUCLEAR REACTIONS BY MEANS OF MAGNETIC ANALYZERS. E. A. Romanovskii and G. F. Timushev. Vestn. Mosk. Univ., Ser. III, Fiz., Astron., No. 4, 56-61(July-Aug. 1963). (In Russian)

Descriptions are given of a double focusing analyzer used in the investigation of nuclear reactions, especially particle polarization. (tr-auth)

2008 HIGH LIGHT POWER POLARISCOPES OPERATING WITH MAGNETIC ANALYZERS FOR LOW AND MEDIUM ENERGY PROTONS. I. Grancha, E. A. Romanovskii, G. F. Timushev, and M. M. Khasani. Vestn. Mosk. Univ., Ser. III, Fiz., Astron., No. 4, 62-7(July-Aug. 1963). (In Russian)

Descriptions are given of carbon and helium polariscopes operating with magnetic analyzers. A proton analyzer operating with a carbon source polariscope is highly efficient. Helium polariscopes were used for measuring neutron polarization. (tr-auth)

2009 ULTRA-HIGH VACUUM IONIZATION GAUGES WITH DIRECTLY HEATED ELECTRODES. C. Y. Hwa, S. Y. Wang, and Z. C. Chang. Wu Li Hsueh Pao, 19: 83-9 (Feb. 1963). (In Chinese)

The necessary conditions of ultra-high vacuum ionization gauges are briefly reviewed. The design and operation of two types of ionization gauges of pressure range $10^{-3}-10^{-11}$ Torr are described. All the electrodes of these gauges can be degassed by resistance heating. They are simple in construction, easy to operate, and of shorter degassing time. No special power supplies are required. (auth)

2010 ELECTRICAL RESISTIVITY TANK (Engineering Materials). (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). (CAPE-662)

This package contains 3 drawings. The apparatus is used for remote measurement of the electrical resistance of small irradiated metal test specimens of various sizes and shapes. It employs the potential drop method of resistance measurement. Results of electrical resistance measurements are used to record changes that occur in metals subjected to irradiation. The apparatus consists of a specimen-gripping mechanism that is installed in an insulated tank containing an oil bath. The temperature of the oil bath regulates the specimen temperature and is controlled by coils submerged in the oil. The specimen-gripping mechanism is capable of holding cylindrical or rectangular specimens $\frac{1}{16}$ to $\frac{1}{2}$ in. in dia. or width and $\frac{3}{4}$ to 6 in. in gage length. The overall length of the specimen is restricted by the tank dimensions to 12 in. The insulated tank that holds the mechanism is $15 \times 12 \times 7\frac{1}{2}$ in. (F.S.)

2011 AN AUTOMATIC FROST-POINT HYGROMETER USING RADIOACTIVE DETECTION. John G. Ballinger (Honeywell Military Products Group, Minneapolis). 36p. (CONF-89-6)

From International Symposium on Humidity and Moisture, Washington, D. C., May 1963.

The surface upon which the dew or frost forms in this hygrometer is an alpha emitter that is maintained at the frost-point temperature by electronically controlled heating and cooling. A solid-state alpha detector converts changes in the alpha energies due to changes in the frost-layer thickness into changes in the amplitude of voltage pulses. Such instruments presently respond to a 1 μg cm^2 change in front-layer thickness. Also, the detection sensitivity is constant for any water state. (D.C.W.)

2012 DEVELOPMENTAL STUDIES OF NUCLEAR DIGITAL TRANSDUCERS. James L. Hyde (Charter Wire, Inc., Northport, N. Y.). Chicago, Instrument Society of American, 1963, Preprint 43.2.63, 8p, $1.00. (CONF-147-8)

From Instrument Society of America Conference, Chicago, Sept. 1963.

A pressure transducer based on mechanical modulation of a beam of alpha particles is described. This type of transducer is capable of direct digital pressure measurement with corresponding telemetry advantages. Any variable that is sensed through a mechanical displacement is measurable by means of a corresponding member of this transducer family. Preliminary tests of an experimental pressure transducer show an overall accuracy within a few tenths of one percent, with promise of substantial improvement. General characteristics of nuclear digital transducers include exceptional long-term calibration stability and accuracy, independent of ambient environmental effects. Three concepts of systems employing these transducers are discussed. (auth)

2013 NUCLEAR CONTINUOUS WEIGHING SCALE FOR SOLIDS ON CONVEYORS. Snowden Rowe (The Ohmart Corp., Cincinnati). Chicago, Instrument Society of America, 1963, Preprint 58.2.63, 8p, $1.00. (CONF-147-6)

From Instrument Society of America Conference, Chicago, Sept. 1963.

Development of a nuclear weighing scale for all types of conveyors is completed. The theory of operation of this system, with the practical considerations and descriptions of the equipment acquired, sources of error, and actual operating history on several installations in the cement industry on belt and vibrating conveyors are given. (auth)

2014 CALIBRATION OF RADIATION TYPE DENSITY MEASURING INSTRUMENTS. F. R. Gilmer and C. M. Drummond (E. I. du Pont de Nemours & Co., Wilmington, Del.). Chicago, Instrument Society of America, 1963, Preprint 61.3.63, 8p, $1.00. (CONF-147-4)

From Instrument Society of America Conference, Chicago, Sept. 1963.

A procedure is described for calibrating radiation-type density instruments, where the density instruments are more accurate than the laboratory analyses by which they can be calibrated. The least-squares regression technique is used to establish a calibration curve with 95% confidence limits. A control chart is plotted from the accumulated data and the regression equation. This chart is used to indicate possible instrument drift. None is detected. It should be noted that this method may be used on any type of instrument calibration where the method of calibration is less accurate than the instrument. (auth)

2015 RADIO-FREQUENCY MASS SPECTROMETERS AND THEIR APPLICATIONS IN SPACE. A. S. Gilmour, Jr. (Cornell Univ., Ithaca, N. Y.). 20p. (CONF-297-1)

From International Conference and Exhibit on Aerospace Support, Washington, D. C., Aug. 1963.

The operation of three common radio-frequency mass spectrometers is described, and their performances are compared. Their limitations are pointed out. It is concluded that the quadrupole spectrometer has fewer limitations and is more generally useful in space probes than the other devices. Some present and proposed uses of spectrometers in space are discussed, and the problem of contamination of the atmosphere being sampled by the spectrometer is reviewed. (auth)

2016 MEASURING APPARATUS. William Thompson and Frank Roper Berry (to United Kingdom Atomic Energy Authority). U. S. Patent 3,109,308. Nov. 5, 1963. Priority date July 3, 1959, Great Britain.

An apparatus was designed for measuring the length and weight of a column of repetitively produced bodies, particularly nuclear fuel pellets which are to be enclosed in a can. The apparatus comprises a channel, a reciprocating push member at one end of the channel for feeding the pellets one by one onto the channel, detector means at the other end, and means for arresting the feed when the detector movement exceeds certain limits. (D.L.C.)

2017 METHOD AND APPARATUS FOR LOCATING BOREHOLE CEMENT BY THE USE OF GAMMA RAYS. Billy F. Wilson (to Well Surveys, Inc.). U. S. Patent 3,110,807. Nov. 12, 1963. Filed July 22, 1959.

A method is given for distinguishing between cement and other substances (particularly water) in the annulus between the casing and the borehole wall of a cased borehole. In this method, the borehole is irradiated from a first place inside the borehole, using gamma rays of such energy that they penetrate the casing and the substances in the annulus but not the borehole wall, and the scattered gamma rays are detected at a second place within the borehole which is displaced axially from the first place. A well logging device for carrying out the method is described. (D.L.C.)

2018 SELF-PROPELLED NUCLEAR RADIOMETER. Arnold Kramish. U. S. Patent 3,110,811. Nov. 12, 1963. Filed May 23, 1960.

A radiometer is described which uses a nuclear radiation source to produce preferential heating of a vane structure. In the construction of the vane structure, a coating of radioactive material is applied to one face of a mica element to which a sputtered gold coating has been previously applied, and finally the radioactive coating is covered with a sputtered gold coating. Possible applications of the radiometer are described. (D.L.C.)

Radiation Detection

Refer also to abstracts 1497, 1498, 2563, 2585, 2747, 2837, 2840, and 3043.

2019 (CLOR-I-B-IBJ-18) THE MOSAIC TYPE SILICON SURFACE-BARRIER DETECTOR FOR LOW LEVEL ALPHA PARTICLE SPECTROMETRY. J. Roman (Poland. Biuro Pelnomocnika Razdu do Spraw Wykorzystania Energii Jadrowej. Centralne Laboratorium Ochrony Radiologicznej, Warsaw); J. Chwaszczewska (Polish Academy of Sciences. Inst. of Nuclear Research, Warsaw); and A. Kuchciński (Poland. Biuro Pelnomocnika Rzadu do Spraw Wykorzystania Energii Jadrowej. Centralne Laboratorium Ochrony Radiologicznej, Warsaw). 1962. 13p. (CONF-305-1)

From Symposium on Technical Aspects of Radiological Protection, Warsaw, Sept. 1962.

The design and operating characteristics of a mosaic-type silicon surface-barrier detector with a sensitive area of 180 mm^2 for spectroscopic identification of alpha-emitting nuclides in low activity samples are given. The counter is suitable for study of alpha spectra in samples of total activity down to 10^{-12} C with a background of less than 0.005 count per minute. (auth)

2020 (EUR-289.e) FAST NEUTRON SPECTROMETRY IN PILE BY THRESHOLD DETECTORS. M. Bresesti, A. M. Del Turco, A. Ostidich, A. Rota, and G. J. Segre (European Atomic Energy Community. Nuclear Research Center, Ispra, Italy). 1963. 41p.

Experiments performed in heavy water and swimming pool reactors using Np^{237}, U^{238}, Th^{232}, S^{32}, Ni^{58}, Al^{27}, and Fe^{56} targets are described. The methods used to determine the reaction rates by beta or gamma activity measurements are explained, and two methods for fission rate determination are compared. Fast neutron distribution spectra were calculated from the activation data by different elaboration methods; a new method is proposed. The methods are compared. (auth)

2021 (HW-77609(Sect.2)) RADIOLOGICAL PHYSICS. (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). 56p.

A shadow shield whole-body counter was calibrated for Zn^{65} and Cs^{137}. It was used to count over 700 people, mostly Eskimos, in several villages north of the Arctic Circle in Alaska during the summer of 1962. Body burdens of Cs^{137} up to more than 100 times the average in the rest of the United States were found. The urinary excretion rate for Cs^{137} was determined to be 0.6% of the body burden per day, or 0.22%/g of K excreted in urine. The high levels of Cs^{137} were linked to a diet containing reindeer and caribou meat resulting from high levels of accumulation in lichens. Procedures and results are reported for the in vivo determination of P^{32} in the human body and measurements of

neutron-induced Na^{24}, and K^{42}, Au^{198}, and P^{32} in persons exposed in the Recuplex accident. The calibration of a variety of radiation detectors is described. The half life of Sb^{124} was found to be 60.20 ± 0.01 days. (C.H.)

2022 (HW-77609(Sect.5)) INSTRUMENTATION. (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). 49p.

Instruments developed or modified include: an automatic data system for atmospheric physics studies; a phosphorescent particle detection instrument for use with ZnS tracer; a monitoring system for protective clothing; a circuit for a liquid effluent radiological monitoring system; a portable radiation survey instrument; a solid state scintillation α detector; and radiation dosimeters with audible or visual signals. A technique for the measurement of neutron dose; development of a contaminated air monitoring technique; a coincidence counting method for Pu contaminated filters; and the development of a detector for airborne Be are presented. (C.H.)

2023 (RISO-44) LOW LEVEL COUNTING. J. Lippert (Denmark. Atomenergikommissionen. Forsøginstitut, Risø). Mar. 1963. 73p.

Presented are a survey of low level counting in general and a discussion of a type of anticoincidence counter in particular. (auth)

2024 (RT/EL(63)9) UN COMPLESSO PER IL COMANDO AUTOMATICO E L'ELABORAZIONE DELLE INFORMAZIONI DI UNO SPETTROMETRO PER NEUTRONI UTILIZZANTE UN CALCOLATORE NUMERICO. (A System for the Automatic Control and the Elaboration of Information from a Neutron Spectrometer Utilizing a Numerical Calculator). E. de Agostino (Italy. Comitato Nazionale per l'Energia Nucleare. Laboratorio di Elettronica, Rome) and B. Turko (Institut "Rudjer Boskovic", Zagreb). June 1963. 26p.

A fully automatized control system for neutron spectrometers is described. The system works with a 1620 type IBM data processing system, which prepares the instructions for spectrometer operation on punched tape. The measured data and all necessary instructions are printed out and punched on tape, ready for final treatment by the data processing system. (auth)

2025 (TID-18358) ALPHA PARTICLE ENERGY RESOLUTION IN A LIQUID SCINTILLATOR. D. L. Horrocks (Argonne National Lab., Ill.). Jan. 1963. Contract W-31-109-eng-38. 27p. (UAC-7228)

An energy resolution of 5.8% was obtained for alpha particles in a liquid scintillator system over the energy range 4.0 to 7.0 Mev. The quenching effects of ethyl alcohol and di(2-ethylhexyl) phosphoric acid were measured. The resolution and relative pulse height were studied as a function of the volume and cross sectional area of the sample. (auth)

2026 (TID-19685) PROGRESS REPORT ON ESTABLISHING AN SMP DATA ANALYSIS SYSTEM AT THE UNIVERSITY OF ILLINOIS. R. I. Hulsizer and J. N. Snyder (Illinois. Univ., Urbana. Digital Computer Lab.). Sept. 26, 1963. Contract AT(11-1)-1018. 4p.

A simple film projector for scanning and measuring pictures of nuclear reactions in bubble chambers was connected directly on-line to IBM 7090 and 7094 computers. After calibration and testing, the system was successfully used to analyze directly measurements for meson(k) scattering in liquid hydrogen. Difficulties in using the computer for other computations while it was processing data were observed. (D.C.W.)

2027 (TID-19688) BUBBLE CHAMBER SCANNING PROGRAM: SYNTAX TABLE FOR THE COMPILATION PHASE OF THE MAIN PROGRAM. Brian H. Mayoh (Illinois. Univ., Urbana. Digital Computer Lab.). May 28, 1963. Contract [AT(11-1)-1018]. 38p.

In the bubble chamber negative scanning program described in TID-19692, the abstracting of information from individual windows involves decisions based on STATE SWITCH. A technique for writing table entries (subroutines) for the STATE SWITCH possibilities is described, and the table entries for 250 of the 273 STATE possibilities originally envisaged are included. (D.C.W.)

2028 (TID-19689) A PROGRAMMING LANGUAGE FOR THE PARALLEL PROCESSING OF PICTURES. Report No. 132. R. Narasimhan (Illinois. Univ., Urbana. Digital Computer Lab. and Illinois. Univ., Urbana. Graduate Coll.). Jan. 9, 1963. Contract AT(11-1)-1018. 25p.

A formalism for describing parallel processing is developed, and a variety of special functions of immediate use in picture processing are introduced. An idea of the structure of a parallel processing computer is thereby obtained, and the ALGOL-60 language is extended to form a suitable algorithmic language for such a computer. Examples of parallel processing routines in this language are included, and applications of the formalism to other areas are considered. (D.C.W.)

2029 (TID-19691) A PREPROCESSING ROUTINE FOR DIGITIZED BUBBLE-CHAMBER PICTURES. R. Narasimhan and James P. Fornango (Illinois. Univ., Urbana. Digital Computer Lab.). July 22, 1963. Contract [AT(11-1)-1018]. 14p.

A computer program for removing noise-introduced distortions from digitized bubble-chamber picture segments is described. Examples of noisy input pictures and the processed output pictures are included along with the program listing. (D.C.W.)

2030 (TID-19692) THE STRUCTURE OF A PROGRAM FOR SCANNING BUBBLE-CHAMBER NEGATIVES. R. Narasimhan and Brian H. Mayoh (Illinois. Univ., Urbana. Digital Computer Lab.). Feb. 7, 1963. Contract [AT(11-1)-1018]. 54p.

A general description of the process covers the input-output features, scanning procedures, data structure, and memory organization. A schematic flow chart for the program MAIN, which is the principal bookkeeping program, is then presented; and input-output features of the SEARCH subsystem and its interaction with the MAIN program are described. The algorithms for the bookkeeping processes are examined in detail. The LABEL subsystem that provides information to SEARCH is described elsewhere. (D.C.W.)

2031 (TID-19695) BUBBLE-CHAMBER SCANNING PROGRAM: 1. LABEL. 2. SEARCH: STAGE 1. R. Kevin Rice and R. Narasimhan (Illinois. Univ., Urbana. Digital Lab.). June 10, 1963. Contract AT(11-1)-1018. 17p.

The program LABEL, which converts the input picture into a labeled graph, thereby generating information for SEARCH, is described. The algorithms used to generate the labeling information are particularly considered. Parallel processing functions used in the algorithms, the program listing, sample output, and a preliminary flow chart for SEARCH are included. (D.C.W.)

2032 (TID-19696) A PRELIMINARY STUDY OF PAU MICROLISTS IN BUBBLE-CHAMBER PHOTOGRAPHS. R. Kevin Rice (Illinois. Univ., Urbana. Digital Computer Lab.). Feb. 1, 1963. Contract [AT(11-1)-1018]. 8p.

In the bubble chamber recognition scheme, photographs are partitioned into windows for which information lists are obtained. The results of an attempt to determine an optimum window size and to specify a first-order grammar for list compilation are presented. The number and percentage of windows having a given number of microlists, as well as the distribution of microlist types, were determined by hand processing two pictures. (D.C.W.)

2033 (UCRL-7489) AN IN-REACTOR RADIOMETRIC CALORIMETER. Stuart R. Gunn (California. Univ., Livermore. Lawrence Radiation Lab.). Sept. 11, 1963. Contract W-7405-eng-48. 14p.

A twin isothermal resistance-bridge calorimeter for use in a pool-type nuclear reactor is described. Measurements of fission energy in U^{235} foils and derivation of the thermal neutron flux are given as examples of its use. (auth)

2034 (UCRL-10986) A COMPARISON OF THE GAMMA ENERGY RESPONSE OF A PORTABLE SCINTILLOMETER WITH THAT OF AN IONIZATION CHAMBER. Francis M. Miller (California. Univ., Berkeley. Lawrence Radiation Lab.). Aug. 22, 1963. Contract W-7405-eng-48. 25p.

Portable scintillometers are used to gather data on fallout and natural background radiation in the San Francisco Bay area. The gamma-ray response of the scintillometers is compared with the response of an integrating ion chamber over an energy range of approximately 1.5 Mev, starting at 0.12 Mev. The results verify the theoretical assumption that the scintillometer response is proportional to the number of γ photons, whereas the ion-chamber response is a measure of the dose, i.e., proportional to the energy of the γ rays as well as to the quantity of the incident gammas. Additional results also demonstrate the validity of using a radium source for calibration of the instruments used for natural background measurements. (auth)

2035 (WCAP-2403) MINIATURE NEUTRON DETECTOR DEVELOPMENT. Quarterly Progress Report, July 1–September 30, 1963. J. Weisman, ed. (Westinghouse Electric Corp. Atomic Power Dept., Pittsburgh). Oct. 16, 1963. Work Performed under Joint United States–Euratom Research and Development Program. Contract AT(30-1)-2827. 19p.

In order to increase radiation lifetime, configurations capable of withstanding 1200 to 1300°C are being developed. Such temperatures should allow substantial annealing of radiation damage. The prime difficulty is the formation of high-temperature contacts. To this end the techniques for bonding W to SiC are investigated. Bonds that can withstand a number of thermal cycles are made, but there are a number of voids at the interface. The yield of good counting diodes is satisfactory. Nearly all diodes produced can count α particles. The single most important factor in the production of good counting devices appears to be crystalline perfection. Two diodes contained in vanadium caps are prepared for in-pile irradiation studies. (auth)

2036 (FTD-TT-63-968(p.223-34)) INVESTIGATIONS OF THE UPPER ATMOSPHERE WITH SATELLITES COSMOS-3 AND COSMOS-5. 1. INSTRUMENTATION. Yu. I. Gal'perin and V. I. Krasovskii (Krasovskiy). Translated from Kosmich. Issled., 1: No. 1, (July-Aug. 1963).

The instruments carried on the Cosmos 3 and 5 satellites and their sensitivities are described. Included were two traps for fast charged particles, five fluorescent-screen electron detectors, and a Geiger counter. (auth)

2037 IONIZATION-DETECTORS FOR GAS CHROMATOGRAPHIC METHODS. H. K. Bothe. Acta IMEKO (Intern. Messtech. Konf.), Budapest, 1961, 4: 335-46(1961). (In German)

A survey of the purpose and working principles of the gas-chromatographic ionization detectors is presented. A beta detector is described that can be used equally well in laboratory as well as in on-line measurements. The characteristics of the detector can be varied easily by changing its working conditions, and it can be applied for special measurements, as for the detection of exceptionally small quantities of organic gases in inorganic ones, or for the detection of inorganic gases, or in capillary gas chromatography. (auth)

2038 SOME PROBLEMS OF MEASUREMENTS WITH PHOTOMULTIPLIERS. P. Goerlich. Acta IMEKO (Intern. Messtech. Konf.), Budapest, 1961, 4: 487-509(1961). (In German)

The application of secondary electron multipliers can be divided into two groups: photometric and scintillation-counting measurements. Theoretical considerations of the fundamental properties of secondary electron multipliers and practical constructions are discussed. The relation between the signal-noise ratio and energetic as well as time resolution is explained. The demands of scintillation techniques and photometry influence each other or are identical. The considerations are proved by experiments made with M 12 FS type multipliers; the inter dinode voltage has the expected influence on the signal-to-noise ratio and resolution. The relation between the signal-to-noise ratio and signal amplitude as well as the relative amplitude fluctuation and pulse-amplitude is discussed. Problems of short-time measurements are discussed in connection with signal-to-noise ratio. Measurements made with the recently developed K 12 FS 50 multiplier are described. The local sensitivity distribution of the photocathode, its measurement and its importance for the usage is dealt with. Measurement data show that in the case of the venetian-blind multiplier the focusing conditions must not be neglected. The higher noise and higher supply-voltage of the venetian-blind multipliers compared with that of the focused type of multipliers is theoretically and experimentally explained. Data gained with venetian-blind types and focused multipliers, M 12 FS 35 and M 12 FS 120, are compared. Ranges of phototubes and multipliers are demonstrated, as well as their fields of application and directions for running them. (auth)

2039 STATIC PUSH-PULL MODULATION OF PHOTOELECTRIC MULTIPLIERS. B. Kiss, J. Schanda, and Gy. Striker. Acta IMEKO (Intern. Messtech. Konf.), Budapest, 1961, 4: 510-24(1961). (In German)

The method of static push-pull modulation shows all the advantages of the a-c circuits without the draw-back of the application of a mechanic light-interrupter or of the magnetic modulation with its unwanted heat dissipation. The basic principle of this method is as follows: the even and odd dinodes are fed with a-c voltage supperposed on the customary direct voltage in push-pull. By the help of this the multiplication of the succeeding dinodes is modulated periodically. As the alternating voltage is supplied in push-pull, its capacitive effect is very small and the remaining assymetry can be easily neutralized. The circuit worked out shows just as good sensitivity properties as an instrument working with galvanometer or light modulation, but with a more robust and simpler construction. This circuit can be easily adapted to frequency multiplication so that the

scattered signal belonging to the fundamental frequency can be eliminated. (auth)

2040 MEASURING PROBLEMS CONNECTED WITH PURITY INVESTIGATIONS ON RADIOACTIVE SUBSTANCES, USING A SINGLE CHANNEL SCINTILLATION SPECTROMETER. G. Brunner. Acta IMEKO (Intern. Messtech. Konf.), Budapest, 1961, 5: 497-516(1961). (In German)

When using single-channel scintillation spectrometers, special problems arise at relatively high and very low radiation intensities. In the range of high intensities the superposition of pulses may be disturbing. This can lead to the recording of narrow maxima in line spectrograms that can be easily misinterpreted. For the intensity of such superposed maxima a formula is given. The formula corresponds to experimental observations, among others with the effect of temperature on the frequency of pulse superposition. The possibility of application of single-channel spectrometers at very low intensities is limited. The cause may be the electronic instability during the very long time necessary to measure the complete spectrum. An experiment is described in which this disadvantage was eliminated by automatic zero-effect correction at any (discrete) channel positions. The method used to record spectrum differences may also be useful at splitting up complex spectra. (auth)

2041 CALIBRATION OF A FISSION GAS MONITOR. Walter C. Day and Robert F. Selden (Lewis Research Center, Cleveland). Health Phys., 9: 921-5(Sept. 1963).

A method for calibrating β-sensitive gas-monitoring equipment is presented which avoids precise mixing of concentrated active gases with diluent air. This method depends upon neutron activation of the Ar in P-10 proportional counting gas and passage of the active gas successively through the monitor chamber and a porportional counter chamber. The latter serves for the determination of specific activity of the monitor gas. The method is satisfactory for specific activities corresponding approximately to maximum permissible concentration levels. (auth)

2042 CURRENT MODE OPERATION OF GM SURVEY METERS. L. A. Muse, W. E. Graves, and J. Ureste (American Nuclear Corp., Oak Ridge, Tenn.). Health Phys., 9: 943-4(Sept. 1963).

A diagram is presented for the current mode operation of G-M survey meters and applications in routine laboratory surveying are discussed. Advantages of current mode operation include a wider range, extension probes without preamplifiers, non-saturation in high radiation fields, and a simplified circuitry that provides a saving in initial cost and maintenance over conventional pulse mode counters. (C.H.)

2043 RELATIVISTIC INCREASE OF BUBBLE DENSITY ON TRACKS OF FAST PARTICLES IN A FREON BUBBLE CHAMBER. E. Hugentobler, B. Hahn, and F. Steinrisser (Universitat, Freiburg i. B.). Helv. Phys. Acta, 36: 601-21(1963). (In German)

The observation and measurement of a relativistic rise of the bubble density along the path of highly energetic particles in the liquids $CBrF_3$, SF_6, and C_3F_8 is described. The increase in bubble density from minimum bubble density to the bubble density at $\gamma = 100$ is $(32 \pm 5)\%$ in $CBrF_3$, and $(16 \pm 5)\%$ in SF_6 and C_3F_8. Approximate calculations of the energy spectrum of initially bound knock-on electrons showed that a δ-ray theory of bubble formation can explain the observed relativistic rise of the bubble density. (auth)

2044 STUDIES ON CASCADE RELATIONS AND ANGULAR CORRELATIONS. V. Visweswara Rao, V. Lakshminarayana, and Jnanananda Swami (Andhra Univ., Waltair, India). Indian J. Pure Appl. Phys., 1: 383-8(Nov. 1963).

A sum-coincidence scintillation spectrometer was assembled and its suitability for the study of cascade relationships with Co^{60}, Na^{22}, and Sc^{46} sources, was tested. The resolutions and efficiency characteristics of the spectrometer compare favorably with those previously reported. The set-up was also utilized for the study of angular correlations of the well-known cascade 1170-1330 kev in Co^{60}. The results of the measurements justify the usefulness and efficiency of the set-up for these types of measurements. The results of studies with the spectrometer on the angular correlations of the 2088-603 and 1692-603 kev cascades occurring in the decay of Sb^{124} indicate negligible quadrupole contents in the upper transitions in both cases, in agreement with the results of previous investigations. (OTS)

2045 ORIENTATIONAL RESPONSE OF A ČERENKOV COUNTER. Krishan Mahesh (Muslim Univ., Aligarh, India). Indian J. Pure Appl. Phys., 1: 404-6(Nov. 1963).

A simple form of a Cherenkov counter that uses perspex as the Cherenkov medium is described and the orientational response of the counter to its vertical was studied at different thicknesses of the perspex radiator. It was observed that when the counting rate of the detector is measured as a function of its zenithal inclination, the orientational response decreases with decreasing thickness of the radiator material. (auth)

2046 COLOR-CODED DIGITAL PRINT-OUT FOR RADIOISOTOPE SCANNING. Gerald J. Hine (Boston Veterans Administration Hospital and Boston Univ.). J. Nucl. Med., 4: 439-45(Nov. 1963).

A simple method for color coding of radioisotope scans is presented. A carriage moves 8 colored typewriter ribbons beneath the printing stylus so that the printing color changes with the count-rate. It should be possible to install this system in all types of scanners presently in use. The operation of the color-scan requires finding the approximate maximum count-rate. After completion of the scan the results are immediately available in their final form without further processing. A change in color delineates clearly areas of different count-rate without losing any information due to a preselected cut-off level. This provides an unambiguous interpretation of the information contained in a radioisotope scan. (auth)

2047 ACTION OF IONIZING PARTICLES ON THE GELATIN OF PHOTOGRAPHIC EMULSIONS. Marie Ader. J. Phys., 24: 574(July 1963). (In French)

The effects of ionizing radiation upon particle tracks in already-developed nuclear emulsion are studied. It is found that the second irradiation produces a darkening of the emulsion within a cylinder surrounding the original particle track. Causes for this behavior are conjectured. (T.F.H.)

2048 DIRECT MEASUREMENT OF SHOWER ELECTRONS WITH "GLASS-METAL" SPARK CHAMBERS. Ryoichi Kajikawa (Nagoya Univ., Japan). J. Phys. Soc. Japan, 18: 1365-73(Oct. 1963).

The total number of electrons and the lateral and longitudinal distributions and fluctuations in electron numbers in electron-photon showers developing in lead absorbers were observed using glass-metal spark chambers. Measurements were made for five electron energies between 200 and 55 Mev; for primary electron energies of 400 to 500

Mev, the results agree with Messel's Monte Carlo calculation. Electron energies were determined with an uncertainty of 30%, and the linear relation between electron numbers and primary electron energy that was predicted by low-energy shower theories was obtained. The glass-metal spark chamber showed a high multiple track efficiency. (auth)

2049 A SCINTILLATION COUNTER FOR THE MEASUREMENT OF RADON CONCENTRATION IN AIR. A. J. L. Collinson and A. K. M. M. Haque (Borough Polytechnic, London). J. Sci. Instr., 40: 521-3(Nov. 1963).

A method is described for measuring the radon content of three liter samples of atmospheric air without pretreatment. The apparatus used consists of a 12 in. photomultiplier with ZnS(Ag) phosphor and counting chamber. A measured efficiency of 38%, when the phosphor is negatively charged, is in good agreement with theory. The ultimate sensitivity is governed by the background, which is equivalent to a concentration of 5×10^{-14} cl^{-1}. (auth)

2050 RELATIVE ENERGY CALIBRATION OF MONOENERGETIC ELECTRON BEAMS. S. M. Horszowski (Diamond Research Lab., Johannesburg). J. Sci. Instr., 40: 532-4(Nov. 1963).

A stacked foil current measurement technique is described for measuring the range of a beam of monoenergetic electrons. The energy of the beam can then be evaluated by means of a range-energy relationship. The energy range of application depends on the dimensions of the foil stack. In the design proposed the stack can be used for beam energies in the range 0.5–2.5 Mev. (auth)

2051 OPERATING CHARACTERISTICS OF LARGE DIAMETER PHOTOMULTIPLIERS. II. NOISE. Takeshi A. Iinuma (National Inst. of Radiological Sciences, Chiba, Japan). Japan J. Appl. Phys., 2: 652-7(Oct. 1963).

The pulse-height distribution for the photomultiplier noise under a normalized gain was investigated as a function of photocathode to first dynode (P.C.-D.1.) voltage with two types of 7 in. diameter tubes (20th Century: VMP/11/170 and E.M.I. 9623). The two types of tubes showed very different characteristics which were ascribed to the difference in electron-optical structure of P.C.-D.1. system. VMP/11/170 tubes showed an optimal S/N ratio at about 150 v which could be explained by change in tube gain variance with the voltage. Noise spectra for 9623 tubes were critically dependent upon the potentials of two focusing electrodes. Some possible mechanisms for noise variations with 9623 are briefly discussed. (auth)

2052 A SINGLE CHANNEL PULSE HEIGHT DISCRIMINATOR USING TUNNEL DIODES. G. Boucke (Forschungsinstitut der Telefunken AG, Ulm, Ger.). Kerntechnik, 5: 401-4(Oct. 1963). (In German)

The discriminator was developed for pulse height analysis in nuclear radiation measuring techniques. Two series-connected tunnel diode thresholds define the channel. The signal current and a back-biasing current responsible for the channel height flow through both diodes, another back-biasing current that defines the channel-width flows through one diode only. By setting the biasing currents it is possible to vary channel height and width. The temperature coefficient of the thresholds is estimated at about 10^{-5} per degree centigrade. A pulse meeting the channel delivers an output signal when its falling slope crosses the lower threshold. A pulse transcending the channel triggers a tunnel diode memory that suppresses an output signal. Because of the memory the circuit is independent from the rise time of the input pulses. Resolution time is 250 ns. (auth)

2053 THE SCINTILLATION PAIR SPECTROMETER. A. Huebner and H. Schneider (Justus-Liebig-Universität, Giessen, Ger.). Kerntechnik, 5: 405-8(Oct. 1963). (In German)

A pair spectrometer consisting of three scintillation detectors, with which an energy resolution of 4.2% was measured at a gamma energy of 2.62 Mev, is described. The spectrometer sensitivity is about 10^{-5}, i.e., every hundredthousandth quantum emitted from the source is being registered. (auth)

2054 ON THE RESPONSE TO FAST NEUTRONS OF THE BF_3 COUNTER IN HOLLOW-SPHERE MODERATORS OF PARAFFIN. M. Ladu, M. Pelliccioni, and E. Rotondi (Comitato Nazionale per l'Energia Nucleare, Frascati, Italy). Minerva Nucl., 7: 287-8(July 1963). (In Italian)

A method for detecting fast neutrons, consisting of a hollow sphere of paraffin and a BF_3 counter, is described. The response to a source of Po–Be neutrons is nondirectional. The system acts as a point detector. (auth)

2055 AN ANTI-COINCIDENCE β-RAY SCINTILLATION SPECTROMETER. T. J. Kennett and G. L. Keech (McMaster Univ., Hamilton, Ont.). Nucl. Instr. Methods, 24: 142-8(Aug. 1963).

A new type of β-ray scintillation spectrometer having a Gaussian response function for monoenergetic electrons was constructed. By employing an anti-coincidence annulus about a plastic scintillator, partial-energy-loss events are rejected. Distortion effects are considered for cylindrical flat-faced scintillators as well as for the spectrometer developed. In general the spectrometer yields β spectra whose Fermi plots are linear for over 90% of the spectral range. Typical spectra covering a wide range of end-point energies and some β–γ coincidence measurements are presented. (auth)

2056 TIME-BEHAVIOUR OF THE SHORT-TIME PHOTOMULTIPLIER K 14 FS 50. A. Eckardt and R. Prager (Friedrich-Schiller-Universität, Jena, Ger.). Nucl. Instr. Methods, 24: 152-4(Aug. 1963).

Pulse rise time, total electron transit time, and coincidence resolution of the fast photomultiplier K 14 FS50 were measured concerned with the operating voltage and the potential distribution in the multiplier input system. As a light source a hydrogen filled flash lamp was used with a rise time smaller than 1 ns. Under nominal conditions transit time varies by 6.5×10^{-12} s if the operating voltage is changed by 1 volt. Best coincidence resolution was $2\tau = 4 \times 10^{-10}$ s. (auth)

2057 EVALUATION OF RANDOM COINCIDENCES IN A RISING COINCIDENCE OF THE "FAST-SLOW" TYPE. J. L. Lecomte (CEN, Grenoble, France). Nucl. Instr. Methods, 24: 165-71(Aug. 1963). (In French)

In a classical slow-fast coincidence circuit, the random coincidences have several origins that are difficult to appreciate. A model is proposed that enables one to account for all the possible random coincidences. The practical and theoretical evaluation of these combinations lead to the point that the secondary random coincidences caused by the slow coincidences can be neglected in comparison to those given by the fast coincidences, if the resolution time of the slow coincidence circuit, the detector yield, and the source activity are limited. (auth)

2058 THERMAL NEUTRON CAPTURE GAMMAS MEASURED WITH A THREE CRYSTAL PAIR SPECTROMETER WITH INTERNAL TARGET. S. E. Arnell and E. G. Nadjakov (Chalmers Univ. of Tech., Göteborg). Nucl. Instr. Methods, 24: 185-96(Aug. 1963).

An experimental study was made of the possibility of employing the three crystal pair spectrometer with an internal target, using a through reactor channel. The arrangement is intended for investigations of reactions with low cross sections or where use is made of small amounts of separated isotopes. Its performance was tested by investigations of gammas from capture of neutrons in natural nickel, dysprosium, calcium, and in a small enriched sample of Ca^{42}. (auth)

2059 A FAST TIME-TO-PULSE-HEIGHT CONVERTER. H. Jung (Eidgenossische Technische Hochschule, Zurich). Nucl. Instr. Methods, 24: 197-212(Aug. 1963). (In German)

A fast time-to-pulse-height converter was designed with high time resolution for time-of-flight measurements. Conversion was accomplished through the principle of charging of a capacitance by a constant current with special circuitry to achieve improvement in linearity, response, and stability. For instance, the inclusion of a current-stabilizing circuit effects an appreciably better than ten-fold improvement in time resolution and incorporation of a pulse reset markedly shortens the dead time. The converter operates over three ranges: 0–20, 0–50, and 0–100 ns, the time-to-pulse-height conversion being practically linear over each range employed. The output pulse range can be regulated from 0–24 to 0–64 v, and the pulse widths to lie between 0.5 and 5 μs. The pulse range without the output amplifier is confined to 0–9 v. The maximum conversion rate is about 10^6 conversions per sec for output pulses of width 0.5 μs. The time resolution of the time-to-pulse-height converter is smaller than 4.8×10^{-12} sec. (auth)

2060 COINCIDENCE CIRCUIT WITH NANO-SECOND VARIABLE RESOLUTION RANGE AND AVALANCHE TRANSISTORS. G. I. Alon and J. R. Rausch (Laboratoire de l'Accelérateur Linéaire, Orsay, France). Nucl. Instr. Methods, 24: 229-40(Aug. 1963). (In French)

The high-frequency characteristics of avalanche transistors are discussed. Very fast response, a high current gain, low pulse propagation delay, and simple circuitry are features that permit the design of stable coincidence circuits with 2 ns resolving time as well as high-output, narrow-pulse standardizing trigger circuits. It is shown that the overall recovery-time may be reduced to 20 ns by means of a charge feedback element, thus rendering the circuit suitable for use in experiments carried out with pulsed linear accelerators. A simple temperature-compensating circuit is described that maintains the overall resolution constant to within less than 0.2% over a temperature range of 10 to 60°C. (auth)

2061 EFFACEMENT OF SCUM OF SURFACE OF NUCLEAR EMULSIONS. Chin-fan Leang (Centre de Spectrométric Nucléaire et de Spectrométric de Masse, Orsay, France). Nucl. Instr. Methods, 24: 243-4(Aug. 1963). (In French)

A method for removing the scum from the surface of nuclear emulsions is presented. The method is based on the use of a series of organic solvents for washing the emulsion. (C.E.S.)

2062 BUBBLE DENSITY IN A HYDROGEN BUBBLE CHAMBER. B. Sechi-Zorn and G. T. Zorn (Brookhaven National Lab., Upton, N. Y.). Nuovo Cimento (10), 26: Suppl. No. 2, 197-204(1962).

Gap-length measurements on tracks in a hydrogen bubble chamber are used to determine the bubble density. The velocity dependence of the bubble density in the range β = 0.60 to 0.98 is shown to be represented by $1/\beta^{1.91 \pm 0.05}$. No relativistic rise in bubble density is found. This result is in agreement with theoretical predictions. Mechanisms for bubble formation are discussed. (auth)

2063 A METHOD FOR THE DETERMINATION OF CHARGE OF RELATIVISTIC PARTICLES IN NUCLEAR EMULSIONS. A. P. Sharma and P. S. Gill (Muslim Univ., Aligarh, India). Nuovo Cimento (10), 26: Suppl. No. 2, 205-18(1962).

A method of charge determination for relativistic heavy nuclei of cosmic radiation is developed by measuring the mean gap length and the probability of development of a grain on tracks in nuclear emulsions. A theoretical relation between the probability of development (π) and the charge (Z) of a particle is formulated, and an experimental verification is made with well-identified charges in the interval $2 \leq Z \leq 10$. The results are utilized to determine the charges of relativistic particles. On the basis of the frequency distribution of various parameters it is shown that an improvement in the charge resolution of the cosmic-ray primary spectrum can be obtained by using the parameter π. (auth)

2064 PROPERTIES OF A STACK OF THICK NUCLEAR EMULSIONS PROCESSED WITHOUT GLASS BACKING. R. Levi Setti and O. Skjeggestad (Univ. of Chicago). Nuovo Cimento (10), 26: Suppl. No. 2, 219-33(1962).

The routine for the processing of a stack consisting of 117 K-5 pellicles 15 cm × 20 cm × 1200 μm in size is described in detail. Measurements of the lateral shrinkage of the processed pellicles indicate absence of irregular deformations. A multiple scattering calibration on K^- tracks contained in the stack (715 Mev/c momentum) yields, without corrections, an accurate $p\beta$ value in agreement with the known $p\beta$ of the beam. Blob countings on beam tracks show a high degree of uniformity of development throughout the entire depth of the pellicles, a high plateau blob density and good discriminating properties of the emulsion. It is concluded that the qualities of free-processed 1200 μm pellicles are, to all effects, equivalent to those of standard glass-backed emulsions. This enables one to take full advantage, otherwise generally precluded, of the use of such thick pellicles. (auth)

2065 ON MULTIPLE SCATTERING IN NUCLEAR EMULSIONS AT LARGE CELL-SIZES. A. Marzari-Chiesa (Istituto Nazionale di Fisica Nucleare, Turin) and A. Wataghin. Nuovo Cimento (10), 26: Suppl. No. 2, 279-85(1962).

Scattering measurements on 17.2-Bev/c and 729-Mev/c momentum tracks are performed, and the influence of the scattering constant upon the dependence of the spurious scattering on the cell-size is discussed. (auth)

2066 A PHOTOGRAPHIC DOSEMETER FOR THE MEASUREMENT OF PERSONAL DOSES OF ENVIRONMENTAL RADIATION. P. W. Henson (Univ. of Leeds, Eng.). Phys. Med. Biol., 8: 423-38(Nov. 1963).

An attempt was made to develop a pocket dosemeter to measure small doses of radiation delivered at natural background dose-rates. The dosemeter employs cylindrical plastic scintillators in contact with Ilford PM1 film to achieve a sensitivity, at background dose-rates, of 25–30 times that of the film alone. Two Perspex cylinders are used to provide a control density area, and the whole is encased by a light-tight duralumin cassette of wall thickness 2 mm. It has little energy dependence in the range 0.3 Mev–Ra γ, and an almost isotropic sensitivity. Net densities of the order of 0.1 were obtained with two weeks

exposure to background radiation. A series of exposures, made with a person having no occupational connection with radiation, gave a standard deviation of ±10%. Errors are introduced by reciprocity failure and by an exposure temperature dependence effect. The former is not excessive. In the latter, the temperature coefficient of net density of a given exposure dose varies with the dose-rate and the error attributable to this effect in the results is unknown. (auth)

2067 THE REDUCTION OF RESPONSE TIMES IN CADMIUM SULPHIDE RADIATION DETECTORS BY THE USE OF "BIASSING" RADIATION. Barbara A. Turner (Hammersmith Hospital, London), D. H. Mash, and J. F. Fowler. Phys. Med. Biol., 8: 439-50(Nov. 1963).

Cadmium sulphide crystals used as radiation detectors pass currents which are three orders of magnitude greater than those in p-n junction detectors. However, the response times in CdS are several seconds long for exposure rates less than about 30 roentgens per hour of gamma-rays. Very long build-up times due to long storage in the dark can be avoided by priming with a constant, very low, background radiation to keep the traps partially filled. Further large reductions in response times at low exposure rates can be obtained by biassing with a constant background of 0.5–3 roentgens/hour. The consequences and limitations of these methods are discussed and some applications are described. (auth)

2068 THE APPLICATION OF SOME DIRECT CURRENT PROPERTIES OF SILICON JUNCTION DETECTORS TO γ-RAY DOSIMETRY. A. R. Jones (Royal Cancer Hospital, Belmont, Sutton, Surrey, Eng.). Phys. Med. Biol., 8: 451-9(Nov. 1963).

The properties of irradiated silicon pn junctions are discussed in terms of the reverse bias applied to them Measurements, which are presented, show that at lower exposure rates the bias should be reduced or removed because the leakage current falls with bias more rapidly than does the radiation induced current. When the bias is removed, the current obtainable from a shunted pn junction is proportional to exposure rate. The open circuit voltage is proportional to the logarithm of the exposure rate over a range of exposure rates. Measurements were made on pn junctions constructed for nuclear particle detectors and on solar cells as well as lithium drifted pin junctions. The properties of the different kind of detectors are compared and their application to medicine and biology discussed. (auth)

2069 SPACE CHARGE DISTORTION OF THE ELECTRIC FIELD IN A PLANE-PARALLEL IONIZATION CHAMBER. J. W. Boag (Mount Vernon Hospital, Northwood, Middx, Eng.). Phys. Med. Biol., 8: 461-7(Nov. 1963).

The effect of space charge on the electric field in a plane-parallel ionization chamber is considered. It is shown that the electric field strength at the plates is considerably higher than in the center of the gap, even when recombination losses amount to only a few per cent. Consequently, in a chamber which is provided with a system of guard wires or plates, the saturation curve obtained experimentally may show polarity effects due to changes in the volume from which ions are collected. (auth)

2070 INFRARED QUANTUM COUNTER ACTION IN Pr-DOPED FLUORIDE LATTICES. M. R. Brown (Signals Research and Development Establishment, Christchurch, Hampshire, Eng.) and W. A. Shand. Phys. Rev. Letters, 11: 366-8(Oct. 15, 1963).

Infrared quantum counter action in Pr^{3+} doped 0.5% in LaF_3, SrF_2, CaF_2 and 2.5% in BaF_2 at both room and liquid nitrogen temperatures is reported. The results show that the action has application both in spectroscopic measurements and as a narrow-band infrared detector sensitive to more than one infrared frequency. (C.E.S.)

2071 TRANSITION RADIATION IN ČERENKOV DETECTORS. D. K. Aitken, R. E. Jennings, A. S. L. Parsons, and R. N. F. Walker (University Coll., London). Proc. Phys., Soc. (London), 82: 710-22(Nov. 1, 1963).

In connection with the use of gas Cherenkov detectors for the measurement of the energy of electron beams, it was found necessary to take into consideration the modification of the radiation due to the end effects in the detector. Using electrons of energy in the range 26–29 Mev, observations were made of radiation both below and above the Cherenkov threshold, the intensity and angular distribution of which are in good agreement with the transition radiation theory of Frank and Ginsburg and the theory of Cherenkov radiation as formulated by Tamm. The threshold technique as a method of measuring beam energy is considered in the light of the investigations. (auth)

2072 CALORIMETRIC DETERMINATION OF ABSORBED DOSE AND $G_{Fe^{+++}}$ OF THE FRICKE DOSIMETER WITH 10-Mev AND 20-Mev ELECTRONS. Janet Geisselsoder, Karl Koepke, and J. S. Laughlin (Sloan-Kettering Inst., New York). Radiation Res., 20: 423-30(Nov. 1963). (TID-19171)

The construction and operation details of a local absorbed dose microcalorimeter are presented. This calorimeter measures the absorbed dose rate at any desired point within an irradiated medium. The measurement is specific to a sufficiently limited region (2.0 cm in dia, 0.3 cm deep) that the measurement is essentially at a point and no integration or averaging process is necessary to qualify either the absorbed dose, or its rate. The system is sufficiently sensitive to provide about 1% accuracy at dose rates of 50 rads/min. The application of this calorimeter to 10-Mev and 20-Mev incident electrons is described. The use of a secondary standard (Victoreen 25-r chamber) under specified conditions is given together with details of calibration for use with high-energy electrons. The influence of the polarization effect was noted. The Fricke ferrous sulfate dosimeter was also calibrated for these energies of electrons. Samples of dosimeter solution were exposed in a geometry identical with that of the small sensitive region of the calorimeter. A value of $G_{Fe^{3+}}$ of 15.32 ± 0.34 was obtained for 10-Mev electrons, and a value of 15.17 ± 0.28 for 20-Mev electrons. (auth)

2073 SCANNING SINGLE-CRYSTAL MULTICHANNEL X-RAY SPECTROMETER. N. Spielberg and J. Ladell (Philips Labs., Irvington-on-Hudson, N. Y.). Rev. Sci. Instr., 34: 1208-12(Nov. 1963).

The design of a scanning, single-crystal, multichannel x-ray spectrometer for spectrochemical analysis is discussed. This design makes use of two or more sets of reflecting planes in the same crystal, and an individual detector is used for each set of planes. Such an instrument permits the choice of optimum resolution and detection conditions for different spectral regions without compromising source design and without the introduction of mechanical complexity. It is possible also to scan different portions of the spectrum simultaneously. The features of such an instrument are contrasted with other types of spectrochemical analyzing instruments, and some results obtained using such an instrument are described. (auth)

2074 FATIGUE AND SATURATION IN PHOTOMULTIPLIERS. J. P. Keene (Christie Hospital and Holt Radium Inst., Manchester, Eng.). Rev. Sci. Instr., 34: 1220-2(Nov. 1963).

The characteristics of some EMI photomultipliers when operated continuously with large cathode and collector currents are described. It is shown that cathode currents up to about 10 $\mu A/cm^2$ are possible with some types of tubes, the only limitation being cathode deterioration under intense illumination. In other types surface resistivity and space charge prevent operation above about 0.02 $\mu A/cm^2$. Data on collector saturation are given and the effect of dynode heating by large currents with consequent reduction in secondary emission factor is also described. (auth)

2075 TIMING SLOW PULSES FOR FAST COINCIDENCE MEASUREMENTS. Michael G. Strauss (Argonne National Lab., Ill.). Rev. Sci. Instr., 34: 1248-53(Nov. 1963).

The circuit described defines accurately the time of arrival of slow pulses. The circuit consists of a compensated delay univibrator generating a signal whose width increases with the input pulse height so that it ends at a time almost independent of the input trigger amplitude. The trailing edge of this signal shifts only 10 nsec when the input is varied from 0.5 to 10 v, and less than 5 nsec when it is varied between 1 and 9 v. The univibrator was incorporated in a simple fast-slow coincidence circuit. Resolving times (2τ) of 10 to 30 nsec were obtained with Co^{60} and NaI detectors without losing coincident events. (auth)

2076 SOLID-STATE DETECTORS FOR BETA-RAY SPECTROSCOPY BELOW 4.2°K. J. Chin, A. T. Hirshfeld, and D. D. Hoppes (National Bureau of Standards, Washington, D. C.). Rev. Sci. Instr., 34: 1258-9(Nov. 1963).

Surface barrier detectors operated at temperatures below 4.2°K are found to be sensitive to beta radiation throughout the volume of silicon wafer and to give good resolution for conversion electrons. The pulse height and resolution for a 1-mm-thick wafer are found to improve slightly with increasing reverse bias in the region of 300 to 530 v. (auth)

2077 PHOTOMULTIPLIER COOLING CHAMBER. P. E. V. Shannon (Naval Research Lab., Washington, D. C.). Rev. Sci. Instr., 34: 1281-2(Nov. 1963).

The photomultiplier tube is enclosed in an inner chamber which is insulated from the outer chamber. Inlets and exits for the coolant gas, photomultiplier leads, and quartz light pipe are provided. The coolant is compressed air that is passed through liquid nitrogen to obtain −180°C. The chamber was used in conjunction with a 250-mm monochromator with greatly increased resolution. (R.E.U.)

2078 STABLE, HIGH FIELD SILICON p-n JUNCTION RADIATION DETECTORS. G. C. Huth, H. E. Bergeson, and J. B. Trice (General Electric Co., Philadelphia). Rev. Sci. Instr., 34: 1283-5(Nov. 1963).

The geometrical control of a reverse-bias-created depletion region at the surface of a p-n junction by the physical removal of bulk charge is discussed. By the resulting bevel or surface contour, the space charge region is controllably distorted or spread out at the surface resulting in a lower surface field. Two silicon p-n junction geometries are discussed. One is 1200 ohm-cm n-type with a 14° contour angle and the other is 30 ohm-cm n-type silicon with 2 to 3° contour angle. A resolution of 600 kev was measured at 100°C indicating possible high-temperature uses. (R.E.U.)

2079 ENERGY RESOLUTION OF CsI(Tl) SCINTILLATION COUNTER FOR 12.5- TO 100-kev PROTONS. A. C. Riviere and D. R. Sweetman (Atomic Weapons Research Establishment, Aldermaston, Berks, Eng.). Rev. Sci. Instr., 34: 1286(Nov. 1963).

The energy resolution of a CsI(Tl) scintillation counter for protons with energies of 12.5 to 100 kev is described. The crystal edge was beveled to 45° and the crystal was attached to the end window by a thin film of paraffin wax instead of silicon grease. The mounting arrangement of photomultiplier and crystal and the circuit used to define the dynode potentials is shown. (R.E.U.)

2080 RADIATION MEASUREMENT DEVICES AND THEIR APPLICATION IN MEDICINE. Heinz Morneburg (Siemens-Reiniger-Werke AG, Erlangen, Ger.). Roentgen Bl., 16: 273-88(Sept. 1963). (In German)

The utilization of radioactive materials in medicine has increased rapidly since the second world war so that a survey of the necessary measurement devices appeared of interest. After a brief representation of the physical principles, the measurement devices, radiation detectors, and radiation measurement devices used were illustrated. Some examples illustrate their utilization on patients and in work. (tr-auth)

2081 DISCUSSION OF A MAGNETIC COMPTON SPECTROMETER'S IMPROVED RESOLUTION WITH ELECTRIC FIELD ADDED. Gerhard Gilbert (Universität, Marburg, Ger.). Sitz. Ges. Befoerder. Ges. Naturw. Marburg, 81: No. 1, 1-28(1958). (In German)

Compton spectrometry with a magnetic beta spectrometer is discussed. Resolution, transmission, and light intensity of lensed and plain spectrometers were determined for Compton electrons. Path equations and focusing of Compton electrons in the plain spectrometer are discussed. Correction of the radial focusing error by changing the focusing energy using auxiliary electric fields is described. (M.C.G.)

2082 REACTOR-SPECTRUM MEASUREMENTS WITH A NEUTRON DECAY SPECTROMETER. R. A. Karam and T. F. Parkinson (Univ. of Florida, Gainesville). Trans. Am. Nucl. Soc., 6: 239(Nov. 1963).

2083 NEUTRON-FLUX MEASUREMENTS USING MULTIPLE-THRESHOLD DETECTORS. W. W. Gerken and D. Duffey (Univ. of Maryland, College Park). Trans. Am. Nucl. Soc., 6: 239-40(Nov. 1963).

2084 MEAN-SQUARE VOLTAGE-FLUCTUATION MEASUREMENTS WITH NEUTRON-SENSITIVE ION CHAMBERS. R. A. DuBridge (General Electric Co., San Jose, Calif.). Trans. Am. Nucl. Soc., 6: 306-7(Nov. 1963).

2085 A SENSITIVE TRITIUM MONITOR. L. F. Ballard and R. L. Ely, Jr. (Research Triangle Inst., Durham, N. C.). Trans. Am. Nucl. Soc., 6: 400-1(Nov. 1963).

2086 DOSIMETRY FOR MONOENERGETIC FAST-NEUTRON IRRADIATION. R. C. Axtmann and J. A. Licari (Princeton Univ., N. J.). Trans. Am. Nucl. Soc., 6: 412-13 (Nov. 1963).

2087 A LITHIUM FLUORIDE THERMOLUMINESCENT DOSIMETRY SYSTEM FOR DOSE MEASUREMENTS OF RADIATION FROM REACTORS, ACCELERATORS, SPACE, ISOTOPIC SOURCES AND X-RAY GENERATORS. Richard C. Fix and Richard C. McCall (Controls for Radiation, Inc., Cambridge, Mass.). Trans. Am. Nucl. Soc., 6: 413(Nov. 1963).

2088 AN IMPROVED METHOD OF ADIABATIC CALORIMETRY. E. A. Mason, W. N. Bley, G. L. Woodruff,

and G. C. Nullens (Massachusetts Inst. of Tech., Cambridge). Trans. Am. Nucl. Soc., 6: 416-17(Nov. 1963).

2089 TIME-DEPENDENT SCHOTTKY EMISSION IN PHOTOMULTIPLIER TUBES. I. Cantarell (Puerto Rico Nuclear Center, Mayaguez) and A. Macias. Trans. Am. Nucl. Soc., 6: 418-19(Nov. 1963).

2090 A HIGH-SPEED READOUT FOR MULTICHANNEL PULSE-HEIGHT ANALYZERS. W. W. Wilkins, L. E. Fite, and R. E. Wainerdi (Agricultural and Mechanical Coll., College Station, Tex.). Trans. Am. Nucl. Soc., 6: 419-20(Nov. 1963).

2091 EVALUATION OF LARGE VOLUME SCINTILLATION DETECTORS AND THEIR APPLICATION TO RADIOISOTOPE PROCESS CONTROL. J. Kent Perry (Colorado School of Mines Research Foundation, Golden). Trans. Am. Nucl. Soc., 6: 421-2(Nov. 1963).

2092 CRITERIA FOR CHOOSING LIQUID SCINTILLATION COUNTER SETTINGS FOR DOUBLY-LABELED SAMPLES. Elizabeth T. Bush (Nuclear-Chicago Corp., Des Plaines, Ill.). Trans. Am. Nucl. Soc., 6: 422-3(Nov. 1963).

2093 INVESTIGATIONS OF SPARK CHAMBER. Chu-liang Tsou. Wu Li Hsueh Pao, 19: 116-23(Feb. 1963). (In Chinese)

The construction, operating principles, and several characteristics of a spark chamber with eight discharge interspaces and a volume of $70 \times 50 \times 50$ cm^3 are described. The characteristics of the neon-filled chamber are investigated at 1.5 atm. Results show that the spark chamber has 100% efficiency for detecting charged particles in a wide range of impulse voltage. (tr-auth)

2094 CHERENKOV SPECTROMETERS WITH TOTAL ABSORPTION. Hsiao-wei Tang. Wu Li Hsueh Pao, 19: 225-38(Apr. 1963). (In Chinese)

The applications of Cherenkov spectrometers with total absorption for measuring the energy spectra of high-energy electrons and photons are reviewed. The construction and operating principles of the spectrometers are considered. The characteristics of several spectrometers are compared. (tr-auth)

2095 RESOLVING WIDTH OF CRYSTALLINE NEUTRON SPECTROMETER WITH PLANE CRYSTALS. Huang-ch'ao Chang. Wu Li Hsueh Pao, 19: 477-82(Aug. 1963). (In Chinese)

An approximate expression for the resolving width of a crystalline neutron spectrometer with plane crystals is derived. Several crystals are considered, and the results are evaluated on the basis of neutron resonance cross section measurements. (tr-auth)

2096 ALPHA OR BETA GAMMA RADIATION MONITOR [Q-2277] (Engineering Materials). (Oak Ridge National Lab., Tenn.). (CAPE-1049)

This package contains 7 drawings. The transistorized instrument replaces a vacuum-tube type general-purpose monitor. It is a linear count-rate meter with a pulse amplifier and a high-voltage supply for the detector. The charge-sensitive amplifier allows as much as 200 ft of cable between the detector and the instrument. The instrument has improved linearity and no drift in zero or calibration. It provides an alarm that is adjustable to any desired radiation level, a 10 mv recorder output, a 1-ma recorder output, and a 1-ma telemetering output. It may be used with alpha-scintillation probes and with halogen-filled G-M tubes. It automatically compensates for counting losses in the G-M tube. (F.S.)

2097 EXPERIMENTAL DISPERSING DEVICES AND DETECTION SYSTEMS FOR SOFT X-RAYS. David W. Fischer and William L. Baun (Air Force Materials Lab., Wright-Patterson AFB, Ohio). 24p. (CONF-174-6)

From 12th Annual Conference Application of X-ray Analysis, Denver, Aug. 1963.

Instrumentation for soft x ray research is briefly described. Preliminary results are shown for several dispersing systems, which are useful in the 10 to 60 Å region. Results from single crystals of Group 1A salts of phthalic acid are discussed and intensity measurements are reported. Other organic single crystals, such as long-chain derivatives of adipic acid, are evaluated, along with films of organic compounds prepared by the Blodgett-Langmuir technique. The efficiencies of these dispersing elements are compared with commercial crystals. Performance of detectors for soft x rays is shown for flow-proportional and Geiger counters, a solid-state silicon-barrier detector, and a windowless resistance strip magnetic electron multiplier. The relative efficiencies of several photocathode materials for the latter detector are discussed. The design is discussed for a scintillation counter sensitive over a wide energy range and preliminary results are shown using the counter in the region 1 to 15 Å. (auth)

2098 A FAST NEUTRON SPECTROMETER FOR REACTOR FLUX MEASUREMENTS. A. Keith Furr and R. S. Runyon (Virginia Polytechnic Inst., Blacksburg). 24p. (CONF-46-106)

From American Physical Society 1963 Spring Meeting, Washington, D. C., Apr. 1963.

A neutron spectrometer is constructed that may be employed for neutrons with energies from about 0.5 to 5.0 Mev. The design is a modification of a recoil-proton telescope, and employs a silicon surface barrier diode as a detector. Difficulties with neutron-induced reactions in the diodes themselves from neutrons above 5 or 6 Mev, which affect the performance of "sandwich-type" silicon diode neutron spectrometers, are eliminated. A measurement of the neutron spectrum in a collimated beam from a reactor is made, which shows that the instrument provides a satisfactory means of determining the energy distribution in a non-monoenergetic flux. (auth)

2099 SOLID STATE RADIATION DETECTOR WITH WIDE DEPLETION REGION. Joseph M. Denney, Stephen S. Friedland, and Frank Keywell (to Hughes Aircraft Co.). U. S. Patent 3,110,806. Filed May 29, 1959.

A charged particle radiation detector of a semiconductor type is described which may be operated at ambient temperature. The detector comprises a single-crystal body of silicon having a PN junction and a sensitive area (depletion region) near one face whereby all the ionization produced by charged particles occurs near the sensitive area. The depletion region may be produced by applying a reverse electrical bias to the PN junction. (D.L.C.)

2100 CHARGED FIBRE RADIATION RATEMETER. Donald L. Fauser, Carl R. Seibentritt, Jr., Warren H. Smith, and William R. Polye (to Bendix Corp.) U. S. Patent 3,110,808. Nov. 12, 1963. Filed Mar. 30, 1960.

A simple, fast-reacting ratemeter is designed which measures the radiation rate in r/hr, has a quasi-logarithmic response to the radiation rate, and returns to zero between measurements. The ratemeter comprises a chamber, a U-shaped conductive frame within the chamber, and a flexible resistive fiber connected to the ends of the frame. The fiber and frame are arranged to have a predetermined resistance difference, so that their relative position will change upon application of electrical current flow. Several embodiments of the ratemeter are described. (D.L.C.)

ISOTOPE TECHNOLOGY

General

2101 ABSOLUTE ACTIVITY MEASUREMENTS. H. Ramthun (Physikalisch-Technische Bundesanstalt, Brunswick). Atomwirtschaft, 8: 535-7(Oct. 1963). (In German)

Absolute measurement of activity and preparation of standard activities of radioisotopes in common use are discussed. The introduction of the 4π-counter represented an essential step forward in the technique of these measurements. These counters are equally suitable for use with alpha and beta emitters. The radiation absorption is kept as low as possible by a special technique of preparing the samples. Thin aluminum rings having low radiation absorption serve as specimen carriers, with a plastic foil about 0.0001 mm thick stretched across the central opening. A droplet of the radioactive solution to be measured is introduced on to the center of the foil, weighed and the liquid evaporated. In the main, differential gas counters are used for the absolute measurement of low energy particle emitters such as H^3 and C^{14}. In this case the radioisotope concerned is mixed, in the form of a gaseous compound, with the counting gas so that no absorption correction is involved. There is no need to know the absorption correction in activity measurements by the coincidence method. This is applicable if at least two particles are simultaneously emitted for each nuclear disintegration. Beta-gamma coincidence counting is the most frequently used. In the case of large source strengths microcalorimetric methods may be used to measure activity. Here the total radiation, or a known fraction of it, is absorbed in the calorimeter wall and is ultimately converted into heat. The thermal power can be determined with accuracy by comparison with the Joule heating produced by an electric current. Powers as low as 10^{-7} w can be measured in the differential calorimeter. (auth)

2102 BASIC CONSIDERATIONS ON RADIOACTIVITY AND ITS APPLICATION. Yukio Murakami. Bunseki Kagaku, 12: 209-21(Feb. 1963). (In Japanese)

2103 ISOTOPES AND RADIATION TECHNOLOGY. Volume 1, No. 1. P. S. Baker, Robert H. Lafferty, Jr., and Martha Gerrard, eds. (Oak Ridge National Lab., Tenn.). Fall 1963. $0.55 (GPO) (domestic), $0.70 (GPO) (foreign). (One of the Technical Progress Reviews prepared quarterly for the Division of Technical Information, USAEC). 126p.

A technical progress review is presented of the following regions of isotope and radiation technology: isotope production and development, process radiation, source development, isotopic power, applications in medicine, safety, and available materials and services. Emphasis is placed on the research and development activities sponsored by the Division of Isotopes Development. Separate abstracts were prepared for the feature article and eight of the nine sections. (D.L.C.)

For abstracts of individual sections see: 1477, 1594, 1981, 2104, 2105, 2106, 2121, 2125, and 2140.

2104 STATUS OF THE U. S. PROGRAM ON ISOTOPES AND RADIATION DEVELOPMENT. E. E. Fowler and P. C. Aebersold (Atomic Energy Commission, Washington, D. C.). p.1-26 of "Isotopes and Radiation Technology. Vol. 1, No. 1."

An authoritative summary is given of the AEC research and development activities. These activities include Radioisotope and Fission-Product Production and Separations Technology, Isotopic Power Fuels Development, Process Radiation Development, Radiation Pasteurization of Foods, and Radioisotope Technology Development. Each of these activities is described in detail, and the research and development projects being carried out for AEC by private research groups are listed. (D.L.C.)

2105 INTRODUCTION TO ISOTOPE TECHNOLOGY. p.27-34 of "Isotopes and Radiation Technology. Vol. 1, No. 1."

A brief general review is presented of the principles of isotope production and utilization. A chronological outline of the development of the isotopes program is given. (D.L.C.)

2106 SOURCE DEVELOPMENT. p.84-8 of "Isotopes and Radiation Technology. Vol. 1, No. 1."

A review is presented of research and development on glasses bearing radioisotopes in insoluble form. The preparation, leaching, and other properties of aluminosilicate glass containing Cs^{137}, Tl^{204}, Sr^{89}, and Ce^{144}, of cesium silicate glass, and of cesium borosilicate glass are reported. (D.L.C.)

Industrial Applications

2107 (TID-6613(Suppl.4)) RADIOISOTOPES IN WORLD INDUSTRY. Abstracts of Selected Foreign Literature. (Division of Technical Information Extension, AEC). July 1963. 172p.

Abstracts of foreign literature on the uses of radioisotopes in the physical and engineering sciences covering the period from Oct. 1962 to July 1963 are presented. The 626 abstracts were grouped by subject and subgrouped by country. Author and country indexes are included. (M.C.G.)

2108 (TID-16050) APPLICATIONS OF RADIOISOTOPES TO MEASUREMENTS OF PISTON RING WEAR AND EVALUATIONS OF ENGINE OILS. I. EXPERIMENTS WITH COBALT-60. II. LITERATURE SURVEY. (Chicago. Univ. Labs. for Applied Science). Mar. 1962. Contract AT(11-1)-712. (LAS-TR-161-41). 260p.

Tracer measurements of the rate of wear of piston rings were made with pile-activated iron rings, with iron rings inlaid with an electrolytically deposited alloy of nickel and radiocobalt, and with pile-activated nickel-inlaid rings. The tests were conducted with three types of engine oil in a single cylinder engine. The concentration of radioactive debris transferred to the lubricant was monitored continuously with a scintillation detector. It was found that the three rings ranked the three oils similarly with respect to ring wear. The applicability of such rate of wear measurements to the evaluation of engine oils is discussed critically, with the conclusion that piston ring wear reduction is but one of many important aspects of engine lubrication. The subject of friction, wear, and lubrication is reviewed, with over 600 references given. (auth)

2109 RELIABILITY OF TRANSDUCERS FOR GAMMA RAYS. T. Tanasescu, T. Ionescu, R. Literat, and S. Meitert. Acta IMEKO (Intern. Messtech. Konf.), Budapest, 1961, 5: 536-56(1961). (In German)

The possibilities of increasing the reliability of transducers for gamma rays operating in automatized plants are dealt with. Causes of faults may be the following: faulty GM tubes, break of the leads between the detector and the amplifier tubes, or voltage break in the mains. Protective measures are proposed, and the manner of estimating factors of safety is given. The theoretical results are applied for the case of the level-measuring instrument using radioactive isotopes in process control. (auth)

2110 RADIOACTIVE METHODS FOR APPRAISING THE QUALITY OF LUBRICATING OILS. D. Pavalescu, I. Iliuc, and S. Barbul. Acta IMEKO (Intern. Messtech. Konf.), Budapest, 1961, 5: 557-73(1971). (In French)

An experimental setup for the investigation of wear is described. For the elimination of the circulation of oil contaminated with the radioactive products of wearing, a system with two and six G-M tubes was worked out. To eliminate the variation of the area of friction surface, first a fixed radioactive preparation was used, but later a sliding one (a ring fastened to the motor axis). For the same reason the radioactive preparation was first a needle, and then a plate of Fe^{59}, surface layers of Ag^{110} and In^{114}, that was introduced before the irradiation of the ring. On the basis of this method an experimental setup was constructed that produced reproducible results and made possible the determination of the lubricating characteristics of simple and additive oils from the point of view of wear. (auth)

2111 APPLICATION OF RADIOACTIVE ISOTOPES IN THE PETROLEUM INDUSTRY. R. Siering. Atompraxis, 9: 424-8(Oct. 1963). (In German)

Radioactive isotopes are used in all branches of the petroleum industry. When searching for petroleum they are irradiated by strong neutron sources on the spot, by means of which the elements contained in the stratification around the well can be activated. The emitted radiation will make it possible to detect mineral oil deposits. For a more productive exploitation of oil fields already discovered the labeling of gas utilized for yield increase proved to be useful. The perfection of the tracer technique and the increased sensitivity permit the control of production process in the refineries. Distillation and refining processes, blending processes, throughputs through pipelines, tank fill quantities, quality of semi-finished and finished products can be controlled and supervised. Shutdown of plants in case of disturbances can be avoided in many cases. In the laboratories radioactive isotopes contribute to the investigation of fuel and lubricant problems. They permit basic studies on the effect of additives and causes and effects of the wear in engines and gears. (auth)

2112 EXTENSION OF STORAGE LIVES OF POTATOES AND ONIONS BY COBALT-60 γ-RAYS. N. F. Lewis and P. B. Mathur (Atomic Energy Establishment, Trombay, India). Intern. J. Appl. Radiation Isotopes, 14: 447-53 (Oct. 1963).

Phulwa potatoes and Red Globe onions were irradiated with 6 krad of Co^{60} γ rays at the rate of 3 krad/min and stored with controls at two temperatures, viz. room temperature (21–35°C; R.H., 57–90 per cent) and cold storage (11–12°C; R.H., 85–90 per cent). The dose employed was sufficient to prevent the sprouting of potatoes and onions at both the temperatures. Decay started earlier in the irradiated potatoes as compared to the controls at room temperature. However, there was no decay in control or irradiated potatoes in cold storage. It appears that irradiation does not destroy part of the reduced ascorbic acid but changes it to the dehydro form which is re-converted to the reduced form on boiling the potatoes. There were no adverse effects on color, texture, taste or flavor in boiled irradiated potatoes after 10 months of cold storage. There was no difference in the extent of waste due to disease between the control and irradiated onions at room temperature. In cold storage, however, no decay occurred in either of the two lots of onions. There was no reduction in the reduced ascorbic acid content of onions after irradiation. Raw irradiated onions were slightly sweeter and less pungent after eight months of cold storage, there being no adverse effects on color and texture. (auth)

2113 WEAR RATES IN AUTOMOTIVE ENGINES BY LIQUID SCINTILLATION COUNTING OF Fe-55. H. H. Ross, R. P. Gardner, and J. W. Dunn, III (Oak Ridge National Lab., Tenn.). Trans. Am. Nucl. Soc., 6: 401-2 (Nov. 1963).

2114 RIFLE INTERNAL BALLISTICS MEASUREMENTS USING GAMMA BEAMS. Michael W. York, Geza L. Gyorey, and John M. Lovallo (Univ. of Michigan, Ann Arbor). Trans. Am. Nucl. Soc., 6: 412(Nov. 1963).

2115 PREFERRED ORIENTATION IN ROLLED ELECTRICAL STEELS BY NEUTRON SINGLE DIFFRACTION. Dick Duffey and M. R. Eugenio (Univ. of Maryland, College Park). Trans. Am. Nucl. Soc., 6: 413-14(Nov. 1963).

2116 FABRICATION OF SEMICONDUCTOR DEVICES BY NEUTRON TRANSMUTATION DOPING. C. N. Klahr and M. S. Cohen (Fundamental Methods Associates, New York). Trans. Am. Nucl. Soc., 6: 414(Nov. 1963).

2117 RADIATION POLYMERIZATION OF VINYL MONOMERS IN WOOD SUBSTRATES. Anthony Winston, William Boyle, James A. Kent, George T. C. Li, William B. Glenn, and Larry D. Hall (West Virginia Univ., Morgantown). Trans. Am. Nucl. Soc., 6: 414-15(Nov. 1963).

2118 BETA RADIATION PROCESSING UNDER RIGOROUS CONDITIONS. P. M. Yavorsky and E. Gorin (Consolidation Coal Co., Library, Penna.). Trans. Am. Nucl. Soc., 6: 415-16(Nov. 1963).

2119 DESIGN OF A HIGH-PRESSURE GAMMA-RADIATION LOOP. L. E. Kukacka, G. Nugent, L. Stone, and M. Steinberg (Brookhaven National Lab., Upton, N. Y.). Trans. Am. Nucl. Soc., 6: 416(Nov. 1963).

2120 PRIMENENIE MIKROELEMENTOV, POLIMEROV I RADIOAKTIVNYKH IZOTOPOV V SEL'SKOM KHOZYAISTVA. TRUDY KOORDINOTSIONNOGO SOVESHCHANIYA PROBLEMONI KOMISSII UASKHN AT 20-21 APRILYA 1960 g. (Application of Microelements, Polymers, and Radioactive Isotopes in Agriculture. Reports of a Coordinate Conference on Ukrainian Agriculture, April 20-21, 1960). Kiev, Ukrainian Academy of Rural Economy, 1962. 300p.

Forty-seven articles are included on the perspectives and aspects of applications of trace elements, polymers, and radioisotopes in agriculture. Radiation effects on corn, beets, wheat, and tobacco harvest are discussed, and results with various fertilizers are analyzed. (R.V.J.)

2121 PROCESS RADIATION DEVELOPMENT. RADIATION ENGINEERING ACTIVITIES AT BROOKHAVEN NATIONAL LABORATORY. Francis X. Rizzo (Brookhaven National Lab., Upton, N. Y.). p.78-83 of "Isotopes and Radiation Technology. Vol. 1, No. 1."

A report is presented of the BNL High-Intensity Radiation Development Laboratory, which was designed for studies of the feasibility of radiation applications in industrial processing. The facility design and program are described in some detail. (D.L.C.)

2122 THE USE OF RADIOISOTOPES IN ON-STREAM ANALYSIS. James W. Haffner (Illinois Inst. of Tech., Chicago). Chicago, Instrument Society of America, 1963, Preprint 31.2.63, 14p, $1.00. (CONF-147-9)

From Instrument Society of America Conference, Chicago, Sept. 1963.

A wide variety of radioisotope techniques is presently in use for on-stream measurements. Among these are gages to measure thickness, density, viscosity, dilution, volume, velocity, and level. A few unique combinations of the above techniques are also detailed—a mass-flow gage, a beryllium-in-air monitor, and a double thickness/double density gage. Several available on-stream techniques utilizing neutrons, which have not been fully exploited, are discussed, including neutron inelastic scattering, neutron thermalization, neutron capture, and neutron activation. (auth)

2123 USE OF ISOTOPES IN INDUSTRY. James W. Haffner and Charles W. Terrell (Illinois Inst. of Tech., Chicago). Chicago, Instrument Society of America, 1963, Preprint 25.3.63, 10p, $1.00. (CONF-147-10)

From Instrument Society of America Conference, Chicago, Sept. 1963.

The radioisotope system chosen for a particular industrial application depends on what is to be measured. The several variables in such a system are discussed, including sources (alpha, beta, gamma, neutron, and bremsstrahlung types); detectors (ion-collecting, scintillation, and physical effects types); and electronics. The various applications of radioisotopes including both measurement and process types are also discussed. (auth)

2124 INDUSTRIAL MEASUREMENT AND CONTROL OF SLURRIES USING RADIOISOTOPE GAGES. H. L. Cook, Jr. (The Ohmart Corp., Cincinnati). Chicago, Instrument Society of America, 1963, Preprint 62.2.63, 11p, $1.00. (CONF-147-5)

From Instrument Society of America Conference, Chicago, Sept. 1963.

Radioactivity gages are available in a variety of configurations to suit the problem of process measurement. The placement of any gage configuration must be selected carefully so that the process material flowing past the gage is representative of actual process conditions. The initial calibration of a gage is relatively simple but when the gage reading is compared with the existing manual sample measurement, confusion can result if the manual measurement is not basically accurate or subject to human error. Routine mechanical and electrical maintenance of the gage is relatively simple, because modern gages use solid-state circuitry with modular plug-in construction. Thus, routine maintenance of the gage is usually limited to re-standardization to compensate for source decay. Two types of zero suppression are available, via. fixed and reduction-with-time. If reduction-with-time suppression is used the re-standardization period is about ten times longer than that required for fixed-zero suppression. Routine maintenance of the process piping and machinery is necessary to assure that a representative process material sample continues to flow through the gage. (auth)

Power Application

2125 ISOTOPIC POWER DEVELOPMENT. p.89-96 of "Isotopes and Radiation Technology. Vol. 1, No. 1."

A survey is presented of thermoelectric generators using radioisotopes which were designed for remote-area terrestrial use. The generators described include a 5-watt Sr^{90} generator for a weather station in the Arctic, a 10-watt Sr^{90} generator for a light buoy, a Ce^{144} heat source for water desalination, and a 5-watt Cs^{137} generator for an underwater seismograph. The use of calorimetry at ORNL for measuring the rates of heat production by radioisotopes is discussed, and the design and operation of temperature-gradient calorimeters are described. Applications of calorimetric measurements are considered. (D.L.C.)

Separation and Production

2126 (HW-77770) THE HANFORD ISOTOPES PRODUCTION PLANT ENGINEERING STUDY. J. R. La Riviere, L. R. Michels, H. C. Riches, C. A. Rohrmann, C. W. Smith, and W. H. Swift (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). July 1963. Contract AT(45-1)-1350. 72p.

Conceptual design and estimates of capital, operating, and unit costs are made for a plant at Hanford to be used for the production of encapsulated heat sources of Sr^{90}, Cs^{137}, Ce^{144}, and Pm^{147} from wastes. Unit costs per curie are calculated for each of the above radioisotopes. (D.L.C.)

2127 (ORNL-3488(p.21-41)) CHEMICAL SEPARATION OF ISOTOPES. (Oak Ridge National Lab., Tenn.).

The kinetics of exchange and the selectivity coefficients of alkali metal ions in Dowex 50 resins of various cross-linkages were studied in ethylenediamine solutions. The lithium isotope separation factor for the system Amberlite ion exchanger IR-120–Li^+ vs 2 N LiCl was determined to be 1.003 ± 0.001. Anhydrous LiSCN was prepared from $LiOH \cdot H_2O$ and NH_4SCN by the precipitation of $LiSCN \cdot (C_2H_5)_2O$ and desolvation by vacuum distillation. Isotopic equilibrium constants were determined for the exchange of boron between BF_3 (gas) and the BF_3–organic (liq) complexes of tetrahydrofuran, ethyl ether, ethyl sulfide, and nitrobenzene. The single-stage separation factor for nitrogen between NO_3^- and NO_2^- was found to be 1.057 at 0°C and 1.055 at 10°C. The factor for the pair NO_2^-/NO is 1.024 at 0°C. Nitrogen-15 is enriched in the first-mentioned species of each pair. The nitrogen isotope effect in the thermal decomposition of α,α'-azobisisobutyronitrile and benzene diazonium chloride at 40° is the same for both compounds: $k^{14}/k^{15} = 1.045$. The isotope effect in the reduction of NO_3^- and NH_2OH by tin(II) is small and nearly equal in the two cases: k^{14}/k^{15} for $NO_3^- = 1.007 \pm 0.001$, and for $NH_2OH = 1.004 \pm 0.002$. When Fe(II) was used in alkaline solution to reduce NO_3^-, NO_2^-, or NH_2OH to ammonia, an isotope effect favoring N^{14} was observed. For NO_3^-, $k^{14}/k^{15} = 1.070$ at 25° and 1.058 at 110°. The effect is similar for NO_2^- and NH_2OH, being 1.033 at 25° and 1.028 at 110°. The single-stage separation factor for rubidium and cesium in the system aqueous alkali hydroxide–alkali amalgam was determined at various temperatures and concentrations. One determination was also made for each of the pairs potassium-sodium, potassium-rubidium, and potassium-cesium. Preparation of beryllium amalgam by several electrolytic procedures was attempted without success. The heating together of beryllium and mercury to 650°C for 1 hr resulted in a solution whose beryllium content was less than 20 ppm. Nuclear magnetic resonance chemical shifts were measured for liquid XeF_3, XeF_4, $XeOF_4$, and XeF_6, and F^{19}–Xe^{129} spin-spin coupling constants for XeF_4 and $XeOF_4$. Kinetic data for the exchange of BF_3 between $(C_2H_5)_2O \cdot BF_3$ and $(CH_3)_2O \cdot BF_3$ were obtained from the F^{19} NMR spectra of eight mixtures of $(C_2H_5)_2O$, $(CH_3)_2O$, and BF_3. Raman and infrared spectra of $BF_3 \cdot$ diethyl ether and $BF_3 \cdot$ tetrahydrofuran were recorded for both the B^{10} and B^{11} compounds. The spectra were compared

with that of BF_3 · dimethyl ether and assignments made of the skeletal frequencies. The isotopic data were used to calculate theoretical equilibrium constants for isotopic exchange between the complexes and BF_3. These values were compared with experimental separation factors. The infrared and Raman spectra of aqueous oxalate ion were investigated. The data are consistent with a staggered (D_{2d}) configuration for the ion rather than a planar configuration as suggested by many investigators. The Raman spectra of solid XeF_2, gaseous XeF_2, solid XeF_4, solid XeF_6, and liquid $XeOF_4$ were observed and assignments made of the observed bands. (auth)

2128 (ORNL-TM-658) ISOTOPIC SEPARATIONS. Progress Report, April–June 1963. L. O. Love, comp. (Oak Ridge National Lab., Tenn.). Nov. 14, 1963. Contract W-7405-eng-26. 45p.

Progress is reported on inhomogeneous field separator development; magnetic field studies, ion source studies, ion receiver studies, spectrographic studies of calutron ion beams, beryllium separation studies, chemical aspects of isotope separation, electromagnetic separations, heavy element separations, and thermal diffusion. (J.R.D.)

2129 (TID-19592) SEPARATION OF ISOTOPES. Annual Progress Report. T. I. Taylor (Columbia Univ., New York). Sept. 1, 1963. Contract AT(30-1)-755, 212p. (CU-16-63 AT(30-1)-755-Chem)

Eight papers are presented which describes the progress made on various isotope separation projects. The first paper is in the nature of an introduction and a summary of the progress, while the other papers discuss in detail such topics as O^{18} exchange with CO_2, N^{15} separation, deuterium exchange in methyl acetylene–water, and CO_2 solubility in amine solutions. Separate abstracts were prepared for the last seven of the papers. (D.L.C.)

For abstracts of individual papers see: 1492, 2130, 2131, 2132, 2133, 2134, and 2135.

2130 (TID-19592(Sect.II)) MONOETHANOLAMINE–CO_2 EXCHANGE SYSTEM FOR OXYGEN-18 SEPARATION. A. R. Gupta and T. I. Taylor (Columbia Univ., New York). 36p.

An investigation was conducted on the possibility of increasing the rate of exchange and the rate of approach to equilibrium in the amine carbamate–CO_2 system. The following factors were studied: increase of temperature, catalyst, reduction of hold-up in the product refluxer, and solvent. The results are compared with Cohen's theory of approach to the steady state. A comparison is made of the CO_2–carbamate exchange system with other systems for the separation of O^{18}. (D.L.C.)

2131 (TID-19592(Sect.III)) FRACTIONATION OF NITROGEN ISOTOPES BY CHEMICAL EXCHANGE BETWEEN NITRIC OXIDE AND NON-AQUEOUS SOLUTIONS OF N_2O_4 COMPLEXES. M. Jeevanandam and T. I. Taylor (Columbia Univ., New York). 45p.

A study was made of nonaqueous systems of N_2O_4. Single-stage separation factors were determined for the exchange of NO with N_2O_4 in several solvents at a number of temperatures, and the effects of complexing agents such as 1,4-dioxane and tetrahydrofuran were also studied. Column experiments were carried out on several of the most promising solutions, and the overall separations were studied. (D.L.C.)

2132 (TID-19592(Sect.IV)) CATALYSIS OF THE CHEMICAL EXCHANGE OF NITROGEN-15 BETWEEN NITRIC OXIDE AND NITRIC ACID IN A BUBBLE CAP COLUMN. J. Garbazevich and T. I. Taylor (Columbia Univ., New York). 85p.

The catalytic effect of H_2SO_4, $CoSO_4$, $Fe_2(SO_4)_3$, and $NaNO_3$ upon the system NO–HNO_3 for the exchange of nitrogen-15 using a bubble cap column is reported. When H_2SO_4 was used with 6M HNO_3 and 10M HNO_3, an improvement in the efficiency of the process was obtained, while the salts used with 6M HNO_3 resulted in a reduction of the efficiency of the process. Cohen's equations for the analysis of the time approach to equilibrium gave for 6M HNO_3 a value for α, the single stage equilibration factor, of 1.062 ± 0.006 and for 10M HNO_3, an α of 1.064 ± 0.003. For 6M HNO_3, η, the efficiency, was 21% and for 6M HNO_3–1M H_2SO_4, η was 31%. For 10M HNO_3, η was 31%, and for 10M HNO_3–2M H_2SO_4, η was 36%. (auth)

2133 (TID-19592(Sect.V)) INVESTIGATION OF DEUTERIUM EXCHANGE BETWEEN METHYL ACETYLENE AND WATER. E. G. Mahadevan and T. I. Taylor (Columbia Univ., New York). 6p.

A study of the deuterium exchange in the methyl acetylene–water system was undertaken to evaluate its use in a dual-temperature process for enrichment of heavy water. Preliminary experiments were made to determine the rate of the exchange and the separation factor, using ion exchange resins as catalysts. (D.L.C.)

2134 (TID-19592(Sect.VI)) EXPERIMENTS ON THE EXCHANGE OF OXYGEN-18 BETWEEN WATER AND CARBON DIOXIDE. David Meranda (Columbia Univ., New York). 34p.

Experiments using a kinetic apparatus were made to test the effectiveness of several catalysts for the oxygen-18 exchange reaction in the CO_2–H_2O system. Half times of the order of 1 second were obtained for the best catalysts, but exchange column tests of these catalysts were not encouraging. (D.L.C.)

2135 (TID-19592(Sect.VIII)) COORDINATION COMPLEXES FOR USE AS CATALYSTS IN ISOTOPIC EXCHANGE REACTIONS OF CARBON DIOXIDE. Peter Chou (Columbia Univ., New York). 8p.

The properties and composition of carbonic anhydrase, an enzyme which catalyzes the conversion of CO_2 into H_2CO_3, are discussed with respect to its possible use in speeding up the oxygen-18 exchange rate in the H_2O–CO_2 system. Investigations were made to find cobalt complexes for catalyzing the oxygen-18 exchange between monoethanolamine carbamate and CO_2, and the 1,10-phenanthroline complex $Co(phen)Cl_2$ was selected. This complex was prepared for exchange column experiments. (D.L.C.)

2136 ISOTOPE SEPARATION. Ryohei Nakane. Bunseki Kagaku, 12: 91-101(Jan. 1963). (In Japanese)

2137 THE SEPARATION TUBE. XXVI. CONCENTRATION DISTRIBUTION OF POLYNARY ISOTOPIC MIXTURES IN SEALED SEPARATION TUBES. Klaus Clusius and Eva Varde (Universität, Zürich). Helv. Chim. Acta, 46: 2146-56(1963). (In German)

From the system of differential equations for the distribution of an isotopic mixture in a separation tube, $\gamma_1 = [\gamma_{1o}\, e^{(m_k - m_1)\zeta} / \sum_{j=1}^{n} \gamma_{jo}\, e^{(m_k - m_j)\zeta}]$ was obtained in good approximation, where m_i is the mass number of the component i and ζ is the length coordinate of the separation installation. Its unit was experimentally determined. The mole fractions at the zero point ($\zeta = 0$) of the separation tube installation $\gamma_{10}, \gamma_{20}, \ldots \gamma_{n0}$, which enter as integration constants, are, however, in general, unknown and must be determined from the condition that the mass of each component must be maintained. The method of calculating the integration constants γ_{io} (i = 1, 2, ... n), beginning with the limiting case of vanishing tube length in which the γ_{io} are

identical with the mole fractions in the initial mixture γ_{ia}, is described. These γ_{ia} values serve as the first approximation value for a tube of finite but short length. By iteration, the γ_{io} values were improved so long as the mass conservation integrals led to the initial γ_{ia} values. The method was gradually extended to large separation tube installations. The distributions calculated for two krypton mixtures are shown graphically. (tr-auth)

2138 PRACTICAL, USABLE METHODS FOR ISOTOPE SEPARATION. W. Walcher. Physik. Bl., 16: 61-72(1960). (In German)

Processes for the separation of isotopes are reviewed. Some examples of amounts and costs of separated isotopes are given. (M.C.G.)

2139 CHROMATOGRAPHIC MEASUREMENTS OF LITHIUM ISOTOPE SEPARATION BY ION EXCHANGE. D. A. Knyazev (Mendeleev Chemico-Technological Inst., Moscow). Zh. Fiz. Khim., 37: 1639-40(July 1963). (In Russian)

A chromatographic method was used for measuring coefficients for Li^6 and Li^7 separation for three ion exchange systems: sulfocation KU-2 (10_1 divinyl benzene) 1) in mixed H–Li form–LiCl + HCl aqueous solution with total concentration 0.05 N; 2) identical system with sulfocations SBS; and, 3) mixed Li–NH form–LiCl + NH_4Cl solution with total concentration 0.07 N in 6.0 N ammonia. The results are in agreement with published experimental and theoretical data. (R.V.J.)

2140 ISOTOPE PRODUCTION AND DEVELOPMENT. p.35-52 of "Isotopes and Radiation Technology. Vol. 1, No. 1."

Fission product separations are discussed. The Fission Products Development Laboratory at ORNL is described, and the processing steps involved in the production of Sr^{90}, Cs^{137}, Ce^{144}, and Pm^{147} are described in detail. The electromagnetic separation of enriched stable isotopes is discussed, and some of the results obtained are given. Typical uses for enriched stable isotopes are tabulated. (D.L.C.)

MATHEMATICS AND COMPUTERS

Refer also to abstract 1334.

2141 (ANL-6768) APPLIED MATHEMATICS DIVISION SUMMARY REPORT, JULY 1, 1962 THROUGH JUNE 30, 1963. (Argonne National Lab., Ill.). Contract W-31-109-eng-38. 102p.

Summaries of the computer programs initiated or modified are listed, and the programs developed for the GUS digital computer complex are described. Information included in bulletins or newsletters on computers is indicated, and the new routines for the IBM-704, IBM-1401, and GEORGE are listed. The computer equipment (including GEORGE) presently available for computations is briefly described. An automatic data processing system (CHLOE) was developed for spark chamber photograph analysis. It uses a fiber optics cathode ray tube scanner and an ASI-210 digital computer. (D.C.W.)

2142 (EUR-462.f) TABLES DE MOMENTS EXPONENTIELS. (Tables of Exponential Moments). R. Nicks and C. Pleinevaux (European Atomic Energy Community. Nuclear Research Center, Ispra, Italy). 1963. 8p.

The variation of $x^n e^{-\beta x}$ in the exponential moment $I_n = \int_0^1 x^n e^{-\beta x}\, dx$ is displayed for several values of β and n. The expression $I_n(\beta) = e^{-\beta}\{(1/n+1) + [\beta/(n+2)(n+1)] + [\beta^2/(n+3)(n+2)(n+1)^+ \ldots]\}$ is obtained by application of a recurrence formula and a substitution. (D.C.W.)

2143 (HMI-B31) NÄHERUNGSMETHODEN ZUR LÖSUNG ELLIPTISCHER PARTIELLER DIFFERENTIALGLEICHUNGEN. (Method of Approximation for Solution of Elliptical Partial Differential Equations). F. Stummel (Han-Meiter-Institut für Kernforschung, Berlin). Sept. 1963. 24p.

Approximation methods for the solution of linear elliptical partial differential equations were discussed. The problem of the convergence of the solutions of differential equations compared with solutions of the pertinent differential equations was considered with functional analytical auxiliaries. The estimation of the error in approximation solutions was discussed in connection with the orthogonal projection method. The iterative solution of boundary value problems for elliptical difference and/or differential equations was described in the framework of the Hilbert space formulation of this problem. (tr-auth)

2144 (IDO-16921) COMPUTER GENERATION AND TESTING OF RANDOM NUMBERS. L. J. Gannon and L. A. Schmittroth (Phillips Petroleum Co. Atomic Energy Div., Idaho Falls, Idaho). Aug. 1963. Contract AT(10-1)-205. 41p.

The need for random numbers, particularly in regard to Monte Carlo applications, and the multiplicative mixed congruential methods most commonly used to obtain random numbers are discussed. Both methods involve somewhat arbitrary parameters. Proofs for the lengths of period for both methods and a derivation of an expression for the serial correlation coefficient in terms of the parameters of the mixed congruential method are presented. The results of a series of statistical tests made to determine satisfactory parameters are listed. The length of run test was found to be the most powerful test in that it rejected the largest number of parameters as unsatisfactory. The multiplicative method (for the parameters tested) was superior to the mixed congruential method. The multiplicative method multiplier $\lambda = 2^{18} + 3$ satisfactorily passed all tests and has a short multiply time. (auth)

2145 (IDO-16925(p.67-75)) METHODS OF STATISTICALLY EXAMINING RECORDS AND INVENTORIES. R. G. McMillan (Union Carbide Nuclear Co. Y-12 Plant, Oak Ridge, Tenn.). (Y-KN-629)

Application of the binominal distribution to the examination of records and inventories is discussed. It is assumed that some number or record entries or inventory items will be examined to verify that the entries are correct. An approach to the problem of determining an appropriate number of entries to check and a suitable rule for deciding if the results are satisfactory is presented. (auth)

2146 (IDO-16925(p.87-93)) METHODS OF DEFINING LIMITS OF UNCERTAINTY FOR COMPLEX SYSTEMS. F. W. Spraktes (Phillips Petroleum Co. Atomic Energy Div., Idaho Falls, Idaho).

Complex systems generally have the property that the variable under investigation is a function of several fundamental process measurements. These measurements, as well as the function may have errors associated with them. The limits of uncertainty of a variable which was calculated from such a set of measurements is estimated. As an example, the variable considered is the total uranium content in a tank and the measurements are the volume of solution in the tank and the concentration of uranium in the solution. (M.C.G.)

2147 (NP-13311) NUMERICAL TABLE OF INTEGRAL OF THREE SPHERICAL HARMONICS. A. Mukherji (Saha Inst. of Nuclear Physics, Calcutta; Columbia Univ., New York); and A. S. Chakravarty (Columbia Univ., New York). [nd]. 11p.

Some relations are given for the spherical harmonics forming an irreducible representation of the rotation group, and numerical values of integrals of the type $(Y_l^m(\theta,\phi)/Y_k^q(\theta,\phi)/Y_{l'}^{m'}(\theta,\phi))$ are tabulated in the range $l,k,\Gamma \leq 6$. (auth)

2148 (ORNL-TM-726) A FORTRAN PROGRAM FOR CALCULATING DIFFUSION COEFFICIENTS AND PLOTTING PENETRATION CURVES. F. R. Winslow (Oak Ridge National Lab., Tenn.). [1963]. Contract W-7405-eng-26. 8p.

A computer program for calculating diffusion coefficients from the thin film solution to Fick's law is described. The program, in FORTRAN for the CDC-1604, also machine plots concentration-penetration curves. The program listing is included. (auth)

2149 (TID-19690) SYNTACTIC DESCRIPTIONS OF PICTURES AND GESTALT PHENOMENA OF VISUAL PERCEPTION. Report No. 142. R. Narasimhan (Illinois. Univ., Urbana. Digital Computer Lab.). July 25, 1963. Contract AT(11-1)-1018. 32p.

The Syntactic model is extended to incorporate in the resulting descriptions of pictures the same kinds of data organization that characterize the visual process. Computer-processed output features exhibiting the Gestalt features are included. The Syntactic Model is also shown to provide a ready comprehension of the occurrence of

ambiguous figures. Implications of the model and their relevance to empirical results connected with visual perception are considered. (D.C.W.)

2150 (WAPD-TM-379) BKSB—A REVISION OF THE BKS SYSTEM FOR THE PHILCO-2000 COMPUTER. R. B. Smith and O. F. Swift (Westinghouse Electric Corp. Bettis Atomic Power Lab., Pittsburgh). Aug. 1963. Contract AT(11-1)-Gen-14. 91p.

A computer program that automatically performs certain logical and manual tasks required in normal start-up procedures to load and begin execution of independent digital programs on the Philco-2000 computer is described. The main extension to the BKS program is the addition of the ability to process relocatable programs. (auth)

2151 ON THE REPRESENTATIONS OF THE SEMI-SIMPLE LIE GROUPS. [PART] II. G. E. Baird and L. C. Biedenharn (Duke Univ., Durham, N. C.). J. Math. Phys. (N. Y.), 4: 1449-66(Dec. 1963).

The explicit determination of the matrices of the generators of the unitary groups, SU_n, is carried out and discussed in two alternative treatments: by purely algebraic infinitesimal methods, and by Young-pattern techniques employing the Schwinger-Bargmann boson-operator methods. The implication of this result for a tableau calculus is discussed and a determination of the $[\lambda] \times [1]$ Wigner coefficient for all SU_n is indicated. (auth)

2152 A CLASS OF NULL FLAT-SPACE COORDINATE SYSTEMS. Ezra T. Newman and T. W. J. Unti (Univ. of Pittsburgh). J. Math. Phys. (N. Y.), 4: 1467-9 (Dec. 1963).

A new coordinate system, intrinsically attached to an arbitrary timelike world line, is investigated in flat-space time. The Maxwell field tensor associated with the field of an arbitrarily moving charged particle assumes a particularly simple form in this, its intrinsic coordinate system. This reference frame is expected to be useful in general relativity, in asymptotic studies of radiation, and equations of motion. (auth)

2153 SOLUTION OF LINEAR INTEGRAL EQUATIONS USING PADÉ APPROXIMANTS. J. S. R. Chisholm (European Council for Nuclear Research, Geneva). J. Math. Phys. (N. Y.), 4: 1506-10(Dec. 1963).

It is shown that the exact solution of a nonhomogeneous linear integral equation with a kernel K of rank n is given by forming the Padé approximant P(n,n) from the first 2n terms of the perturbation series solution. It follows that for a compact kernel K, the solution is $\lim_{n\to\infty} P(n,n)$; this gives meaning to a large class of perturbation series when the perturbation is large. The possible extension of this result to wider classes of equations is discussed. (auth)

2154 A NEW METHOD FOR ANALOG TO DIGITAL CONVERSION. C. Cottini, E. Gatti, and V. Svelto (Laboratori CISE, Milan). Nucl. Instr. Methods, 24: 241-2(Aug. 1963).

A method is suggested to improve the differential linearity of analog-to-digital converters for multichannel pulse height analyzers. The method is explained for a feedback coding system. (C.E.S.)

2155 EXPONENTIAL REPRESENTATION OF COMPLEX LORENTZ MATRICES. J. S. Lomont (Polytechnic Inst., Brooklyn) and H. E. Moses. Nuovo Cimento (10), 29: 1059-67(Sept. 1, 1963).

It is shown that every proper, complex Lorentz matrix L can be expressed in the form $L = \sigma \exp [AG]$, where A is an antisymmetric matrix, G is the metric matrix, and $\sigma = \pm 1$. It is then shown that not every proper, complex Lorentz matrix L can be expressed in the form $L = \exp [AG]$, with A and G as above. (auth)

2156 ANALOG-TO-DIGITAL CONVERSION OF ANY k OUT OF n SIGNALS. R. J. Spinrad (Brookhaven National Lab., Upton, N. Y.). Rev. Sci. Instr., 34: 1269-70(Nov. 1963). (BNL-7102)

The technique used is that of analog premixing of weighted portions of the n signals. An example is given which might be applied to coincidence measurements in nuclear physics. (R.E.U.)

METALS, CERAMICS, AND OTHER MATERIALS

General

Refer also to abstracts 1898, 2403, and 3038.

2157 (BMI-1644(Del.)) PROGRESS RELATING TO CIVILIAN APPLICATIONS DURING AUGUST 1963. Russell W. Dayton and Ronald F. Dickerson (Battelle Memorial Inst., Columbus, Ohio). Sept. 1, 1963. Contract W-7405-eng-92. 80p.

Progress is reported on developments in reactor materials and components, fuel studies, general fuel element technology, radioisotope and radiation applications, tracer systems for in-place filter evaluation, materials evaluation, coated-particle fuel technology, corrosion technology, USAEC/AECL cooperative program, fission-product deposition technology, gas-cooled reactor programs, specific heat measurements, and regenerative cell fabrication. (J.R.D.)

2158 (EURAEC-176) THE USE OF PLUTONIUM AS FUEL IN NUCLEAR REACTORS. Quarterly Report No. 5, July 1–September 30, 1961. (Société Belge pour l'Industrie Nucléaire, Brussels and Brussels. Centre d'Étude de l'Énergie Nucléaire). Oct. 1961. Work Performed under United States–Euratom Joint Research and Development Program. Contract 027-60-7-RDB. 38p. (BN-6110-01)

Plutonium dioxide, prepared from precipitated oxalate, dissolves easily in a nitric acid-hydrofluoric acid mixture. The effects of iron on the fluorometric analysis of uranium was determined. As regards the potentiometric analysis of plutonium, the choice of indicator electrode, the effects of catalysers, and the reagent addition rate were examined. Plutonium carbide was produced from plutonium dioxide and graphite. By uranium dioxide vibration, densities around 89% of the theoretical density were obtained. By cold swaging densities around 94% of the theoretical density of uranium dioxide and 91% of the density of uranium carbide were obtained. The zirconium alloy powders produced have a lower hydrogen content than powders obtained commercially. Zirconium and Zircaloy-2 dispersions were fabricated. Dilatometric results were obtained on stoichiometric and substoichiometric plutonium dioxide and plutonium dioxide-uranium dioxide mixtures. The phases of the niobium-zirconium alloys were established. Different chemical baths for polishing niobium-zirconium alloys were tried for their preparation with a view to corrosion tests. Tensile tests on niobium-zirconium alloys were made along with creep tests. A heat conductivity measurement instrument was developed. (auth)

2159 (GEMP-28A) HIGH-TEMPERATURE MATERIALS PROGRAM PROGRESS REPORT NO. 28, PART A. (General Electric Co. Advanced Technology Services, Cincinnati). Nov. 11, 1963. Contract AT(40-1)-2847. 36p.

Progress is reported on the developments in high-temperature materials research in terms of: radiation effects of beryllia; fission-gas diffusion in unfueled ceramic materials; internal conversion ceramic fuel elements; and fission-product-transport processes in refractory-metal fuel systems. (B.O.G.)

2160 (HW-68600-28) PLUTONIUM ABSTRACTS. Volume 3, Number 6. (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). July 1, 1963. Contract AT(45-1)-1350. 10p.

A bibliography of 22 references in abstracted form is presented on new developments in plutonium technology. The references are arranged according to biology and medicine, chemistry, metallurgy and ceramics, physics, and reactor technology. (D.L.C.)

2161 (HW-76302) CERAMICS RESEARCH AND DEVELOPMENT OPERATION QUARTERLY REPORT, APRIL–JUNE 1963. (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Contract AT(45-1)-1350. 106p.

Progress is reported for numerous projects in ceramics research, fuels development, and fuels testing and analysis. (D.L.C.)

2162 (IITRI-B198-46) IMPROVED ZIRCONIUM ALLOYS. Quarterly Report, August 1, 1963–October 31, 1963. D. Weinstein and F. C. Holtz (Illinois Inst. of Tech., Chicago. IIT Research Inst.). Oct. 25, 1963. Work Performed under United States–Euratom Joint Research and Development Program. Contract AT(11-1)-578. 29p. (EURAEC-888)

The development of a zirconium-base alloy superior to Zircaloy-2 for application in 680°F water has—on the basis of corrosion resistance, strength, and hydrogen pickup characteristics—been successfully accomplished. In particular, the materials Zr-0.75Cr-0.4Te and Zr-0.5Nb-0.4Te have exhibited properties which are significantly improved over Zircaloy-2 and could be applied to in-core reactor uses. Study of a wide variety of alloys in 750°F steam was fruitful. For this atmosphere, certain alloys of Zr-Cr-Fe of moderate alloy concentration and Zr-0.75V-0.75Fe exhibit highly acceptable corrosion resistance on the basis of 4000 hours' exposure. The strength of these materials at 750°F appears satisfactory. However, the hydrogen pickup characteristics are not fully known, and it must be shown that reasonably acceptable mechanical properties are maintained at hydrogen contents of up to about 200 ppm. For the 900°F steam medium, further effort should be devoted to alloy development. Perhaps acceptable corrosion resistance can be obtained with Zr-2Cr or Zr-4Fe ternary modifications; however, the pickup of corrosion hydrogen would be fairly substantial. (auth)

2163 (IS-700(Sect.M)) METALLURGY DIVISION. (Ames Lab., Ames, Iowa). 97p.

Research and development progress in metallurgy is reported. Topics covered include: metal preparation, purification, and related studies; phase equilibria and thermodynamic properties of alloys; mechanical properties of metals and alloys; solid-state investigations; separation studies; and other investigations. (M.C.G.)

2164 (ISC-1029(Rev.)) HIGH PURITY METALS AVAILABLE FROM AMERICAN PRODUCERS. H. A. Wilhelm and R. E. McCarley, comps. (Ames Lab., Ames, Iowa). Aug. 1963. Contract W-7405-eng-82. 59p.

A large number of high-purity metals, ranging from actinium to zirconium, which are available in America, are listed together with their impurities and producers. Their hazards, methods of preparation, available forms and sizes, and prices are also indicated. Some listings include grades of lesser purity, especially for some of the less common metals. (D.L.C.)

2165 (NCSC-2663-14) URANIUM INTERSTITIAL PHASES. Quarterly Report. John V. Hamme and Robert F. Stoops (North Carolina State Coll., Raleigh). Sept. 1963. Work Performed under United States–Euratom Joint Research and Development Program. Contract AT (40-1)-2663. 17p. (EURAEC-867)

Hot pressed and vacuum sintered specimens of $U(C_{0.75}O_{0.25})$ were made. Hot pressing, which is the more promising of the two techniques, has yielded specimens with a maximum density of 12.5 g/cm^3. Uranium mononitride was made by hydriding uranium chips followed by nitriding at 1400 to 1500°C with nitrogen gas. The nitriding was followed by a thirty minute soaking period in argon before cooling in argon to insure the decomposition of the higher nitrides. A complete range of solid solution was found to exist between UC and UN. The lattice parameter change versus the composition of the solid solution deviated only slightly from Vegard's law. The existence of solid solutions of U(C,N,O) was indicated by several reactions of UN with $U(C_{0.75}O_{0.25})$, and chemical analyses are being made to check these results. (auth)

2166 (NLCO-890) SUMMARY TECHNICAL REPORT FOR THE PERIOD, JULY 1, 1963 TO SEPTEMBER 30, 1963. (National Lead Co. of Ohio, Cincinnati). Oct. 28, 1963. Contract AT(10-1)-1156. 44p.

Six papers are included which treat various topics related to the properties and fabrication of U. These topics include temperature measurement in U remelt, casting of U, friction of U with mill roll materials, texture gradients of fuel cores, tensile properties of U–P, and dehydration of green salt. Separate abstracts were prepared for all the papers. (D.L.C.)

For abstracts of individual papers see: 1612, 2200, 2201, 2202, 2224, and 2225.

2167 (NP-13261) THE INFLUENCE OF URANIUM ADDITIONS TO FERROUS ALLOYS. An Interim Review. R. F. Knight and D. K. Faurschou, eds. (Canada. Dept. of Mines and Technical Surveys; Canada. Dept. of Mines and Technical Surveys. Mines Branch; Eldorado Mining and Refining Ltd., Eldorado, Saskatchewan; and Canadian Uranium Research Foundation, Toronto) Apr. 1962. 345p.

Available as Can. Dept. Mines and Tech. Surveys, Mines Branch Research Rept. R-59. $1.00.

A research program is being conducted in support of efforts to find new non-nuclear applications for uranium. Some of the results are presented in the form of eleven chapters on the alloying effects of uranium on the various metallurgical, mechanical, corrosion, and other properties of ferrous alloys and steels. Separate abstracts were prepared for ten of the chapters; the remaining chapter was previously abstracted in NSA. (D.L.C.)

For abstracts of individual chapters see: 1503, 1953, 2168, 2169, 2180, 2203, 2227, 2228, 2229, and 2230.

2168 (NP-13261(p.29-55)) A REVIEW OF PUBLISHED WORK AND PATENTS ON URANIUM IN FERROUS ALLOYS. W. A. Morgan and R. D. McDonald (Canada. Dept. of Mines and Technical Surveys. Mines Branch).

The available technical literature and patent files were reviewed to assess the knowledge of uranium-bearing steels and of the production of uranium ferroalloys. The results suggest that uranium improves tensile properties, increases hardenability, induces precipitation hardening, forms carbides which are more stable than those of molybdenum and tungsten, and scavenges oxygen, nitrogen and sulphur. This information, together with that of Chapter 1, forms the basis for planning of most of the uranium projects at the Mines Branch. (auth)

2169 (NP-13261(p.56-95)) RECOVERY AND SEGREGATION IN LABORATORY AND COMMERCIAL STEELS. R. K. Buhr and D. R. Bell (Canada. Dept. of Mines and Technical Surveys. Mines Branch).

The recovery of uranium added to molten steel is extremely variable, and greatly dependent on the oxygen content of the steel. For ladle additions to basic oxygen steel the recovery varied from 7 to 29%. In plain carbon, aluminum-killed, laboratory heats, uranium recoveries based on analyses of the unsegregated areas averaged about 45%. Segregation characteristics or recoveries were not materially affected by the use of different uranium additives in the latter tests. In commercial heats, when the steel was fully deoxidized prior to the uranium addition, recoveries ranged from 49 to 66% regardless of the steelmaking process. Normal basic electric steelmaking procedures removed uranium from the molten bath; hence recirculated scrap would not lead to uranium buildup. Segregation of uranium occurred in all tests in the form of galaxies of small particles of uranium-rich compounds. The distribution of segregates was shown by autoradiography to be related to the solidification rate. With slow cooling rates, equivalent to those of large commercial ingots, most of the uranium-rich compounds settled to the bottom portion of the ingot or casting. With the faster cooling rates of most of the laboratory ingots, the galaxies were small and more dispersed. The segregated areas were high in uranium, oxygen, acid insoluble aluminum, and, in some cases, slightly high in nitrogen. The unsegregated areas were very low in total oxygen and acid insoluble aluminum, and occasionally lower in nitrogen. There was no segregation of carbon, manganese, silicon, sulphur, phosphorus, chromium, or copper to the uranium-rich areas. (auth)

2170 (ORNL-3512) INSTRUMENT FOR DETERMINING CRUSHING STRENGTH OF PARTICLES. George Hallerman and R. J. Gray (Oak Ridge National Lab., Tenn.). Nov. 29, 1963. Contract W-7405-eng-26. 14p.

An instrument for crushing-strength determinations of uncoated and pyrolytic-carbon-coated fuel particles (50 to 500 μ in diameter) was developed to relate the crushing strength of the particles to their fabricability. The instrument consists of a loading mechanism, load cell, and a power supply-readout unit. The information that can be obtained by statistical methods of the data analysis is illustrated by results on two batches of fuel particles. (auth)

2171 (PLASTEC-14) SUBJECT INDEX, BIBLIOGRAPHY, AND CODE DESCRIPTION OF TECHNICAL CONFERENCE PAPERS ON PLASTICS, FEBRUARY 10, 1962–FEBRUARY 10, 1963. Arnold E. Molzon (Picatinny Arsenal. Plastics Technical Evaluation Center, Dover, N. J.). Aug. 1963. 102p.

The papers presented at the technical conferences on plastic materials and related technology, within a one-year period ending 10 February 1963, were listed and indexed by subject. Over 500 papers from 22 conferences are covered. This report serves as a guide to the subjects presented, and by means of a numerical code system, it tells the reader what type of information each article contains. Included are a bibliography and lists of references thereto, on plastic materials and technical data. The conferences were: Society of Plastics Engineers; 19th Annual Technical Conference; Regional Technical Conference on Extrusion and Applied Rheology; on Encapsulation Materials and Technical Workshop; on Reinforced Plastics for Electronics and the Space Age; on

What's New in Thermosets–Society of the Plastics Industry, Reinforced Plastics Division 18th Annual Technical and Management Conference–U. S. Air Force Aeronautical Systems Division: Conference on High Temperature Polymers and Fluid Research; Conference on Structural Plastics, Adhesives and Filament Wound Composites; Symposium on Materials Information Retrieval; Symposium on Fibrous Materials–British Plastics Federation, Reinforced Plastics Group 3rd International Reinforced Plastics Conference–U. S. Naval Ordnance Laboratory-ASTM Symposium on Standards for Filament Wound Reinforced Plastics–National Research Council 31st Annual Conference on Electrical Insulation–7th JANAF Conference on Elastomer Research and Development–U. S. Army Electronics Research and Development Laboratory 11th Annual Symposium on Technical Progress in Communication Wires and Cables-1962 Cryogenic Engineering Conference–SAMPE: Symposium on Materials Compatibility and Contamination Control Processes; Symposium on the Effects of Space Environment on Materials–International Symposium on Radiation-Induced Polymerization and Graft Copolymerization–Institute of Environmental Sciences Symposium on Product Improvement through Environmental Sciences–1962 Electronic Circuit Packaging Symposium–Building Research Institute Conference on New Joint Sealants. (auth)

2172 (TID-3544(Rev.1)) LIQUID METAL TECHNOLOGY. A Literature Search. James M. Jacobs, comp. (Division of Technical Information Extension, AEC). Aug. 1963. 48p.

A total of 1682 citations to the unclassified report and published literature are presented. References are collected under the following subject groupings: general, alkali metals, bismuth, bismuth alloys, bismuth-lead alloys, cesium, lead, lead alloys, lithium, mercury, mercury alloys, NaK, potassium reactor fuel alloys, rubidium, and sodium. References are repeated in each grouping to which they apply. Author and report number and availability indexes are included. (auth)

2173 (TID-6506(Pt.1, 2nd.Ed.)) SUMMARIES OF FUELS AND MATERIALS DEVELOPMENT PROGRAMS. William L. R. Rice, ed. (Atomic Energy Commission, Washington, D. C.). Mar. 1963. 274p.

This report describes unclassified materials research supported by the Atomic Energy Commission, other than that supported by the Division of Research. Included are projects supported by the Fuels and Materials Development Branch of the Division of Reactor Development, and various projects connected with civilian, military, and space reactor projects. U. S.-Euratom and U. S.-Canadian efforts are also included. The contractors are listed alphabetically, and a subject index is included. (D.L.C.)

2174 (USBM-U-1082) QUARTERLY METALLURGICAL PROGRESS REPORT NO. 20, JULY 1–SEPTEMBER 30, 1963. (Bureau of Mines. Albany Metallurgy Research Center, Ore.). Contract AT(11-1)-599. 26p.

Stainless steel-gadolinium alloys were prepared and tested for mechanical strength and resistance to oxidation and hot-water corrosion. Data show that yield or ultimate tensile strengths were relatively unaffected by increases in gadolinium content. However, with increasing gadolinium, degradation of ductility and impact behaviors were observed. Oxidation and corrosion tests were characterized by weight gains with increasing gadolinium contents. Investigation of the samarium-magnesium system was concluded. Reactivity studies of hafnium carbide in air, up to 1000°C, were started. Investigation of the hafnium-iridium alloy system was almost completed. Macro-cracks have plagued the hafnium carbide casting work. The investigation of three thorium-alloy systems thorium-holmium, thorium-neodymium, and thorium-praseodymium, was initiated. Oxygen may be removed from zirconium by the addition of small amounts of Ti, Dy, Er, Gd, and Sm and maintaining the mixture in a molten state for one hour. Oxygen is reduced from 1600 ppm to about 700 ppm. Fabrication of uranium nitride by melting and casting is evaluated. Physical property study of uranium carbide–uranium nitride compositions was initiated. Conditions which determine the optimum cooling of water-cooled copper melting crucibles were determined. Equipment is being modified to permit a study of film coefficients between the molten metal and the crucible wall. Arrangements were made to obtain 50 pounds of rhenium powder to initiate the study of tungsten-25% rhenium alloy for eventual conversion to tubing. Preliminary small-scale melting studies have begun. (auth)

2175 (EURAEC-211) THE ELABORATION OF METHODS FOR THE FABRICATION OF URANIUM CARBIDES AND UC-BASED CERMETS. Quarterly Report No. 5, July 1, 1961–September 30, 1961. (Nuklear-Chemie und -Metallurgie G.m.b.H., Wolfgang bei Hanau am Main, Germany). Oct. 1961. Work Performed under United States–Euratom Joint Research and Development Program. Contract 061-61-5-RDD. 24p. (A translation).

A semicontinuous facility for the fabrication of UC melting stock produced 90 kg of UC during testing operations. The first tests for the fabrication of uranium carbide rods by centrifugal casting proved successful. The tests were made with the aid of a graphite crucible revolving round a vertical axis, the thick wall of which contained holes into which the molten UC was poured by centrifugal rotation. The rods produced are up to 100 mm long and have a diameter of 13 mm. Thier carbon content is overstoichiometric. Work was begun on the construction of a water-cooled copper crucible in order to preclude carbon absorption from the crucible. It proved possible to swage stoichiometric powder to densities of up to 91.5% t.d. (auth)

2176 SYNTHESIS OF URANIUM CARBIDE MELT STOCK. J. W. Carroll (Atomics International, Canoga Park, Calif.). Trans. Am. Nucl. Soc., 6: 391-2(Nov. 1963).

2177 PREPARATION AND PROPERTIES OF SPUTTERED FILMS. M. H. Francombe (Philco Scientific Lab., Blue Bell, Penna.). 36p. (CONF-209-12)

From American Vacuum Society Meeting, Boston, Oct. 1963.

A review is given of the present status of thin film sputtering techniques, and of some of the more recent investigations on the electrical, magnetic, structural, and semiconducting properties of sputtered films in relation to similar studies on evaporated films. It has been demonstrated that sputtering offers certain advantages over vacuum evaporation, for the deposition of refractory metal films, the preparation of deposits uniform in thickness and physical characteristics over large substrate areas, the growth of undissociated alloy and compound films, and the epitaxy of compounds on single-crystal substrates. Provided simple precautions are observed in order to reduce the level of active contaminating gases, physical properties are often more easily controlled in sputtered films than in those prepared by evaporation. The successful extension of this preparative technique to the field of alloys and compounds, and also the recent, and as yet incomplete, im-

provements in low-pressure sputtering methods opens up several new and challenging fields of research in thin films. Apart from the almost limitless possibilities in the study of new multi-component material systems, virtually nothing is known about the growth and properties of films sputtered in low-pressure environments. Recent, detailed investigations by Wehner and his coworkers have, not only led to a model which successfully explains cathodic disintegration in terms of momentum transfer, but have also shown that atoms are ejected from the cathode with velocities exceeding by orders of magnitude those corresponding to thermal evaporation. Nucleation and growth processes in films produced by the condensation of such energetic particles should show significant differences from those occurring in evaporated films, or in sputtered films where the incident particles lose much of their energy by collisions in a high-pressure plasma. (auth)

Corrosion

Refer also to abstract 3134.

2178 (BMI-X-260) CORROSION RESISTANCE OF NICKEL-BASE ALLOYS UNDER HYDROFLUORINATOR CONDITIONS WITH ALUMINUM DISSOLVING. PART II. P. D. Miller, E. F. Stephan, W. K. Boyd, W. N. Stiegelmeyer, and F. W. Fink (Battelle Memorial Inst., Columbus, Ohio). Oct. 18, 1963. Contract W-7405-eng-92. 28p.

Results of an experiment to determine the dissolution rate of Al in molten $KF-ZrF_4-AlF_3$ salts and to evaluate the corrosion behavior of Inor 8, Hastelloy N, HyMu 80, A Alloy 2, Rod 23, Rod 3, and InCo-61 in this salt system are presented. A discussion of procedures is included along with an outline of conclusions. (J.R.D.)

2179 (CEA-2280) LES RÉACTIONS DU MAGNÉSIUM ET DE SES ALLIAGES AVEC LES GAZ HUMIDES AUX TEMPÉRATURES ÉLEVÉES. (The Reactions of Magnesium and Its Alloys with Moist Gases at High Temperatures). Raymond Darras (France. Commissariat à l'Énergie Atomique. Centre d'Études Nucléaires, Saclay). 1963. 63p.

Thesis submitted to Université, Paris.

The kinetics and reaction mechanisms of Mg alloys or pure Mg with water-saturated O_2, N_2, air, and CO_2 were examined at 350 to 600°C. The chemical reactivity of Mg and the magnesia surface formed in the reaction are discussed in relation to the various gases. It was found that metal sublimation occurs more easily as the surrounding atmosphere is less oxidizing. The activation energy change is systematic and is temperature dependent. The inhibition of magnesium corrosion by water vapor is discussed in relation to fluoridation and when CO_2 is used. The kinetics of Mg oxidation are also examined. (J.R.D.)

2180 (NP-13261(p.207-34)) CORROSION OF URANIUM STEELS. G. J. Biefer (Canada. Dept. of Mines and Technical Surveys. Mines Branch).

Many of the corrosion tests reported were carried out in strongly corrosive media so as to obtain a rapid assessment of the effect of uranium and to indicate the direction for further research. Carbon, low alloy, and stainless steels were tested in a variety of media. In the case of carbon and low alloy steels there were indications of a favorable trend in certain concentrations of hydrochloric and sulfuric acids, and for the stainless steels there appeared to be a tendency to lower weight loss and reduced pitting attack in acidified ferric chloride solutions. Many of the other tests gave inconclusive results and require further investigation. (auth)

2181 (ORNL-3488(p.91-5)) ELECTROCHEMICAL KINETICS AND ITS APPLICATION TO CORROSION. (Oak Ridge National Lab., Tenn.).

Aqueous ions were found to enter into ion exchange with chromate ions bound by the film on passive iron and steel. The kinetics of the process was investigated with various systems and at temperatures from 24 to 77.5°C. The dissolution of crystal-bar zirconium in aqueous solutions containing HF and H_2SO_4 was investigated by means of electrochemical techniques. Capacities were determined by measuring the initial slope of the voltage-time curve resulting from the application of galvanostatic pulses. Steady-state polarization curves were obtained potentiostatically whenever possible, and galvanostatic polarization curves were determined by a pulse technique. The data are explained by assuming that the dissolution reaction involves the continuous formation and dissolution of a film on the surface of the metal. The conventional anodizing equation describes the formation of the film, and the dissolution reaction is controlled by the rate of mass transfer of undissociated HF to the surface of the film. A comparative study of the electrochemical behavior of active iron electrodes in deoxygenated acidic sulfate and benzoate solutions was made. In sulfate solutions, the pH and potential dependencies of the iron dissolution and hydrogen evolution reactions were determined. These results served as a basis for the interpretation of the complex polarization phenomena observed in the benzoate solutions, where a potential-dependent specific adsorption of the benzoate ion is accompanied by an increase in rate of the hydrogen evolution reaction and a decrease in the rate of iron dissolution. (auth)

2182 (CEA-tr-X-517) LA CORROSION DES METAUX ET ALLIAGES POUR RÉACTEURS NUCLÉAIRES. (Corrosion of Metals and Alloys for Nuclear Reactors). Goro Ito. Translated into French from Denki Kagaku, 25: 148-56(1957). 58p. (Includes original, 9p.).

The various problems posed by the corrosion of metals and alloys used for the construction of nuclear reactors are summarized briefly under three topics: corrosion by hot water, corrosion by uranyl salts, and corrosion by liquid metals. 35 references. (J.S.R.)

2183 (EURAEC-285) CORROSION PROBLEMS. Final Report (Draft). (Brussels. Centre Belge d'Étude de la Corrosion; Brussels. Centre d'Étude de l'Énergie Nucléaire; and Brussels. Société d'Études, de Recherches et d'Applications pour l'Industrie). [1961]. Work Performed under United States–Euratom Joint Research and Development Program. 103p. (A translation)

The formation of passivation layers on the surfaces of aluminum and its alloys was studied by the chronopotentiometric method. An electrochemical method for the determination of the thickness of very thin passivating oxide-films on zirconium was developed. The method consists of the oscillographic recording of the potential difference between the metal specimen in aerated potassium sulfate solution and a silver-silver chloride comparison electrode during the application of charge pulses of 100 μAsec, with constant current at varying current densities. Development of a constant-current electrolysis method making it possible to study the passivation and activation phenomena of stainless steels and their constituents was started. An experimental in-pile loop was

constructed with which a study can be made of electrochemical corrosion. The passivation of iron was studied in various electrolytes. Preliminary results on boiler plate steel, stainless steel, and aluminum indicate the feasibility of electrochemical corrosion experiments in a reactor. The design and performance of a transitometer for studying metal corrosion in electrolytes were given. (N.W.R.)

2184 NIOBIUM-BASE ALLOYS FOR NUCLEAR SUPERHEATER APPLICATION. J. A. De Mastry, A. A. Bauer, and F. A. Rough (Battelle Memorial Inst., Columbus, Ohio). Trans. Am. Nucl. Soc., 6: 357(Nov. 1963).

2185 FUEL-CLADDING CORROSION TESTING IN SIMULATED SUPERHEAT REACTOR ENVIRONMENT, PHASE IV: GENERAL AND LOCALIZED CORROSION OF TYPE-300-SERIES AUSTENITIC STAINLESS STEELS. W. L. Pearl, G. G. Gaul, and G. P. Wozadlo (General Electric Co., Pleasanton, Calif.). Trans. Am. Nucl. Soc., 6: 357-8(Nov. 1963).

2186 STRUCTURAL MATERIALS IN LASL LIQUID SODIUM SYSTEMS. Howard I. Bowers and William E. Ferguson (Los Alamos Scientific Lab., N. Mex.). Trans. Am. Nucl. Soc., 6: 364-5(Nov. 1963).

2187 MATERIALS FOR SODIUM/GRAPHITE REACTORS. W. C. Hayes, W. J. Anderson, P. E. Elkins, and D. L. Johnson (Atomics International, Canoga Park, Calif.). Trans. Am. Nucl. Soc., 6: 365(Nov. 1963).

2188 THE DEVELOPMENT OF THE ZIRCALOYS. Stanley Kass (Westinghouse Electric Corp., Pittsburgh). Trans. Am. Nucl. Soc., 6: 366(Nov. 1963).

2189 EFFECT OF FLUORIDE IONS ON THE AQUEOUS CORROSION OF ZIRCONIUM ALLOYS. Warren E. Berry (Battelle Memorial Inst., Columbus, Ohio). Trans. Am. Nucl. Soc., 6: 366-7(Nov. 1963).

2190 ZIRCALOY-2 CORROSION IN AQUEOUS HOMOGENEOUS REACTOR SOLUTIONS. G. H. Jenks (Oak Ridge National Lab., Tenn.). Trans. Am. Nucl. Soc., 6: 367-8(Nov. 1963).

2191 RECENT STUDIES OF THE GROWTH AND BREAKDOWN OF OXIDE FILMS ON ZIRCONIUM AND ZIRCONIUM ALLOYS. J. N. Wanklyn (Atomic Energy Research Establishment, Harwell, Berks, Eng.). Trans. Am. Nucl. Soc., 6: 368-9(Nov. 1963).

2192 FACTORS AFFECTING OXIDATION AND HYDRIDING OF ZIRCONIUM ALLOYS. S. B. Dalgaard (Atomic Energy of Canada Ltd., Chalk River, Ont.). Trans. Am. Nucl. Soc., 6: 370-1(Nov. 1963).

2193 THE FACTORS LIMITING THE UTILIZATION OF ZIRCONIUM ALLOYS IN SUPERHEATED STEAM. H. H. Klepfer and D. L. Douglass (General Electric Co., Pleasanton, Calif.). Trans. Am. Nucl. Soc., 6: 371(Nov. 1963).

Fabrication

Refer also to abstracts 2035, 2837, 3044, and 3159.

2194 (BMI-1652) INVESTIGATION OF FABRICATION TECHNIQUES FOR TUBULAR FUEL ELEMENTS. E. S. Hodge, R. J. Carlson, and E. G. Smith, Jr. (Battelle Memorial Inst., Columbus Ohio). Oct. 28, 1963. Contract W-7405-eng-92. 39p.

Two distinct techniques were considered in preliminary studies to develop fabrication techniques for producing low-cost tubular fuel elements: (1) the assembly, consolidation, and bonding of concentric components; (2) the joining together of flat fuel sheets containing several parallel fuel cores and the subsequent expansion of these cores into parallel tubes. The concentric-component technique was most successful, and tubular fuel elements $\frac{3}{4}$ in. in diameter and 27 in. long were made by this process. These elements possessed dense cores and exhibited almost complete core-cladding bonding where explosive sizing and gas-pressure bonding were used to produce an integral element. Additional development of blending and loading techniques is required to insure a uniform dispersion of UO_2 in the stainless steel matrix. The potential of low cost may be realized because the few operations required to make an element appear very amenable to production techniques. The multiple-tube-assembly approach is also characterized by few operations and appeared promising in the limited study given to it in the program. Further work is needed to optimize the seam welding operation to join the multicore fuel sheets such that fully expanded parallel tubes can be made. (auth)

2195 (CEA-2295) LE SOUDAGE ELECTRIQUE EN BOUT PAR ETINCELAGE DU COMPOSITE FRITTE MAGNESIUM–MAGNESIE (theses). (The Electrical Butt-Welding by Flashing of Sintered Magnesium–Magnesium Oxide Composites (thesis)). Jean Charleux (France. Commissariat à l'Énergie Atomique. Centre d'Études Nucléaires, Saclay). 1963. 30p.

Electrical resistance welding has become quite important since World War II because of the need of a high yield in aeronautical production. Progress has been due in particular to the improvements made in electronically controlled apparatus making possible the automatic control of welding. For the butt-welding of sections requiring either a high production rate or a high quality weld, the flash butt-welding system has been very much developed these last few years. The use of this welding method is of great importance in the field of the bonding of oxidizable metals such as magnesium or aluminium and its alloys, because the welded joint is free from oxides. This study consists of general considerations on the flash-welding process with regard to temperature distribution in the parts during welding, and to electrical phenomena connected with flashing. Besides this general or theoretical section, the welding process was applied to the bonding of sintered magnesium, a magnesium-magnesium oxide composite, whose use as a structural element in nuclear reactors is considered. (auth)

2196 (CEA-2338) TECHNIQUE DE PREPARATION D'ECRANS DE PLUTONIUM POUR LA SPECTROGRAPHIE DE RAYONS X MOUS. (Technique of Preparation of Plutonium Screens for Soft X-Ray Spectrography). L. de Bersuder (France. Commissariat à l'Énergie Atomique. Centre d'Études Nucléaire, Fontenay-aux-Roses and Paris. Universite. Laboratoire de Chimie Physique). 1963. 19p.

Thin layers of pure plutonium (thickness 100 to 10,000 Å) were prepared by thermal vacuum evaporation. The plutonium was protected against oxidation by vacuum deposition of aluminum layers under and above the plutonium layer. The purity of the layers was checked by electron and x-ray diffraction which showed that very thin films of plutonium condense in β form instead of α. (auth)

2197 (EUR-353.d) HERSTELLUNG VON RUND-GEHAMMERTEN UO_2-BRENNELEMENTEN. (Fabrication of Swaged UO_2 Fuel Elements). F. Hofmann, H. Kroll, and B. Liebmann (Nuklear-Chemie und -Metallurgie

G.m.b.H., Wolfgang bei Hanau am Main, German). 1963. 16p. (EURAEC-522)

The suitability for swaging of various kinds of UO_2 powders was tested. As expected, powders with a small BET-surface are most favorable for reaching high swaged densities. Four types of powders have been prepared by different methods: (1) fused uranium dioxide, prepared by a continuous fusing process; (2) powders, prepared by high temperature treatment of ADU; (3) powders, made from uranium peroxide; (4) UO_2 powders, which were improved by soaking with a solution of uranylnitrate and subsequent calcination. Fused powders and powders made from uranium peroxide reached the highest densities. For the fabrication of the fuel elements the powders were tamped into stainless steel tubes of 18 mm OD. The tubes were evacuated, filled with argon, and sealed by welding the end closures. A two die machine was used for swaging. A cold reduction of 20 to 30% in cross section, followed by a hot reduction at 750°C of 20 to 30% in cross section, yielded the highest UO_2 densities. With this method densities between 85–94% TD were reached. The density of the swaged UO_2 was determined by measuring weight and volume. Construction of equipment for determining the UO_2 density and the uniformity of density along the rod by gamma absorption was started. The O/U-ratio of the swaged powders was measured and the pore structure was studied by means of mercury porosimetry. The mean pore diameter in the swaged UO_2 was in the range of 1 μ. (auth)

2198 (EURAEC-118) SWAGING OF URANIUM DIOXIDE. Annual Report No. 1, May 1960–June 1961. G. Frigerio and H. M. Ferrari (FIAT. Sezione Energia Nucleare, Turin). July 31, 1961. Work Performed under United States–Euratom Joint Research and Development Program. Contract 013-60-5-RDI. 40p. (FN-E-10)

Over 70 bars of many different diameters and thicknesses and 30 cm long were swaged to determine the importance of the cladding diameter-to-thickness ratio. It was found that for bars having D_0/T ratios under 18, the density increases with increasing reductions in area of fuel. For intermediate D_0/T ratios from 18 to 26 the density reaches a maximum after about 30% reduction in area and levels off with further reductions. However, with values of D_0/T of 29 and over, the density reaches a maximum and then decreases with further reductions in area. Several reactor length bars were swaged using a semiautomatic feeding device and compared with those obtained by hand feeding. It was found that bars swaged with the feeding device had better surface finish and were straighter. Using the feeding device, stainless steel tubes with wall thicknesses as low as 15 mils were swaged. Stainless steel bars of reactor length loaded with fused UO_2 pneumatically vibrated to 80–82% T. D. were swaged to densities of 92% T.D. or over with 2 passes and a reduction of fuel area of approximately 20%. The variation in density along the bars was an acceptable ±1% T.D. maximum; in some cases the deviations were only ±0.5%. Measurements of the thermal conductivity of fused UO_2 were obtained for 3 samples swaged to different densities. Values were obtained at 150 to 500°C. The thermal conductivity values for swaged UO_2 pellets are lower by 30% at 150° than those obtained by other workers. As the temperature is increased the thermal conductivity for swaged UO_2 is only 20 to 25% below those for pellets at 500°C. It must be noted that a similar test performed on a plain stainless steel rod gave a result 8% lower than the normal figure. Preliminary tests showed that very little UO_2 loss by erosion occurs in swaged UO_2 bars in a static pressurized water environment. (auth)

2199 (NAA-SR-Memo-9088) MICROPROBE STUDY OF BRAZED JOINT FOR SNAP 10A THERMOELECTRIC PUMP APPLICATION. E. L. Reed (Atomics International, Div. of North American Aviation, Inc., Canoga Park, Calif.). Oct. 16, 1963. Contract AT-11-1-GEN-8. 14p.

There is a program requirement to produce sound brazed joints between stainless steel and copper metal components that will remain sound after long time exposure to a high vacuum environment at a temperature of approximately 1000°F. Results are described of a microprobe study of one of the promising brazed joints after long time exposure to high vacuum conditions at a temperature of approximately 1200°F. It was desired to determine the extent of gold diffusion into the stainless steel after long time exposure under accelerated conditions. The brazing test alloy contained 81.5% gold, 15.5% copper, and 3.0% nickel. Microprobe scan photographs are shown for each of the major elements present in the test specimen and a traverse profile sketch of the braze zone is shown for the microprobe equipment set to detect gold and nickel. The results of this microprobe study indicated significant diffusion of gold into the copper metal but no diffusion of gold into the stainless steel. There were indications of minor diffusion of nickel into the copper and perhaps some concentrating of nickel atoms at the surface of the stainless steel. (auth)

2200 (NLCO-890(p.7-16)) EVALUATION OF INFRARED RADIATION PYROMETER FOR MEASURING REMELT POUR TEMPERATURES. G. Brodi, A. E. Abbott, and D. McCright (National Lead Co. of Ohio, Cincinnati).

The temperature of molten uranium was measured indirectly by an infrared radiation pyrometer. The pyrometer was sighted on the crucible graphite pour plug during the entire melting cycle. The pour plug temperature was measured by an embedded thermocouple and the molten bath temperature by an immersion thermocouple. The emissivities of graphite and molten uranium were determined, and a series of equations correlating pyrometer readings with melt temperatures was derived. (auth)

2201 (NLCO-890(p.17-20)) TECHNIQUES FOR PRODUCING URANIUM CASTINGS OF COMPLEX CONFIGURATION FOR PHYSICAL TESTING. G. Brodi (National Lead Co. of Ohio, Cincinnati).

A mold assembly with heating coil and insulation was developed to produce castings of a complex configuration for physical testing. The casting consisted of four small cylinders for mechanical testing surmounted by a larger cylinder for a forgeability test. (auth)

2202 (NLCO-890(p.21-5)) COEFFICIENT OF FRICTION BETWEEN URANIUM AND MILL ROLL MATERIALS. H. W. Hesselbrock (National Lead Co. of Ohio, Cincinnati).

The coefficient of friction was determined between uranium and mill-roll materials. The effects of roll hardness and surface finish, the loading between the two surfaces in contact, uranium surface finish, and uranium temperature were evaluated. (auth)

2203 (NP-13261(p.235-58)) WELDING OF URANIUM-BEARING STEELS. K. Winterton and W. P. Campbell (Canada. Dept. of Mines and Technical Surveys. Mines Branch).

Recovery of uranium in steel weld deposits depends on the joining process. Recoveries of about 26% were obtained with inert-gas tungsten-arc welding. Recoveries of 1 to 2% were obtained with metal-arc welding. The weldability

of uranium-bearing carbon steels was assessed with principal emphasis on the possibility of heat affected zone cracking. Cruciform and controlled-thermal severity tests were made on various steels with carbon content in the range 0.25 to 0.58%, and with uranium content up to 0.23%. Some comments are also made on the possible effect of uranium content on weld-metal cracking, but this was not directly investigated. Longitudinal bead weld tests were undertaken on segregated uranium-bearing steel, and it was found that the presence of uranium-rich segregates in the heat-affected zone does not affect the extent of cracking in that region. The indications are that carbon steels, with uranium up to 0.1%, are weldable under conditions appropriate for similar steels without uranium. Spot welding tests were carried out on steels with lower carbon content in the form of cold-finished sheet. No special difficulties were introduced when small amounts of uranium (about 0.05%) were present. Mention is also made of the satisfactory joining, by resistance butt welding, of low carbon steels containing up to 0.24% uranium. (auth)

2204 (ORNL-3385(p.73)) FABRICATION AND MATERIAL DEVELOPMENT. D. A. Douglas (Oak Ridge National Lab., Tenn.).

Process schemes and equipment were developed for the remote fabrication of fuel elements containing mixtures of thorium and uranium oxides. Equipment for crushing, classifying, and vibratory compaction of oxides, plus equipment for welding, cleaning, and inspection of fuel rods were developed and installed in a lightly shielded facility. Approximately 1100 fuel rods containing U^{233} will be fabricated for criticality, zero power experiments at Brookhaven National Laboratory. The prime developmental work centered around the solution of the proper particle-size distribution to be fed to the fuel rods during vibratory compaction, and the establishment of optimum welding conditions. The second area of major concern was the irradiation performance of mixed oxides of thorium and uranium produced by the sol-gel process. Over 30 capsules containing various versions of sol-gel-prepared oxides were irradiated. Most of these were conducted at process-water temperatures and with rather modest heat ratings. In comparison with mixed oxides obtained by standard methods, the sol-gel-derived fuel proved to be at least as good and, in some cases, slightly better in retaining fission gases. Because of the modest heat ratings, no sintering of the loose fuel particles was observed. Thoria pellet development work was originally undertaken, with the goal of achieving a dense spherical particle having a high attrition resistance. The ultimate purpose was to use these pellets in a fluidized blanket system of a breeder reactor. Fabrication methods were developed whereby density and grain size could be controlled. The use of coatings was investigated and then evaluated by attrition tests. Efforts to improve the resistance of thorium metal to irradiation-induced swelling involve the use of dispersion hardening. The dispersoid selected is thoria in the submicron-particle-size range. The problem involves the development of fabrication procedures to achieve the fine particle size of metal and oxide and to fabricate shapes containing an optimum dispersion of oxide in the metal. (auth)

2205 (WANL-PR-(N)-003) DEVELOPMENT OF HIGH-STRENGTH COLUMBIUM AND TANTALUM ALLOY TUBING. Quarterly Progress Report No. 3, June 1, 1963–August 31, 1963. R. W. Buckman, Jr. and J. L. Godshall (Westinghouse Electric Corp. Astronuclear Lab., Pittsburgh). Oct. 11, 1963. Contract AT(30-1)-3108. 37p.

The feasibility of drawing B-66 to tubing was demonstrated. A solid B-66 rod was gun-drilled and then reduced by drawing, 80%, to 0.5 inch OD × 0.062 inch wall tubing at 600°F. An attempt to draw B-66 to tubing at room temperature was unsuccessful because of a lubrication failure. This resulted in excessive galling between the die and tube OD from which a crack was initiated. Tube drawing is being done at the facilities of the Superior Tube Company. Extrusion of 69 pounds of B-66 and 142 pounds of T-111 tube blanks at a reduction ratio of 7:1 was accomplished at the facilities of Nuclear Metals, Inc. The extrusion constant for the B-66 was 80 to 81.7 ksi and 76 to 85.5 ksi for the T-111. The results of the tube blank extrusions verified the data from the previous extrudability evaluation. The B-66 extrusions were conditioned and yielded 43.75 pounds of tube blanks, a 63% recovery of useable material based on the starting extrusion billet weight. The as-conditioned B-66 tube blanks were successfully warm tube reduced 55% from a 2 inch OD × 0.25 inch wall to a 1.375 inch OD × 0.156 inch wall. (auth)

2206 THE PREPARATION OF UO_2 BY ELECTROLYSIS OF UO_2Cl_2 IN MOLTEN $NaCl-KCl-MgCl_2$ EUTECTIC. M. Schlechter (Reactor Centrum Nederland, Petten, Netherlands). J. Nucl. Mater., 10: 145-6(Oct. 1963).

A method is described for the preparation of UO_2 by electrolysis of UO_2Cl_2. The eutectic mixture of $NaCl-KCl-MgCl_2$ permits the electrolysis to be carried out at a temperature of about 550°C and prevents thermal decomposition of the uranyl chloride. The preparation was performed without using a protective inert atmosphere. The resultant coarse electrolytic UO_2 appears suitable as raw material for the fabrication of fuel elements by swaging methods. (P.C.H.)

2207 TECHNIQUES FOR THE FABRICATION OF ULTRA-THIN METALLIC FOILS. Frank J. Karasek (Argonne National Lab., Ill.). Nucl. Sci. Eng., 17: 365-70(Nov. 1963). (TID-18598)

General procedures and equipment used for the fabrication of ultrathin metallic foils are outlined. Such foils are an essential part of a variety of nuclear parameter measurements. Specific techniques are given for the rolling of Cr, W, Gd, and modified 310 SS foils. By use of a modified pack, rolling to ultrathin gauges can be accomplished on conventional mills. A table is included, listing many additional foils that were produced by the above means. Foil production of this type is a custom operation and suggestions for operational success are given. (auth)

2208 EXPLOSIVE JOINING TUBULAR COMPONENTS OF ZIRCALOY-2 TO TYPE-410 STAINLESS STEEL. Charles C. Simons, Stanley W. Porembka, and R. J. Carlson (Battelle Memorial Inst., Columbus, Ohio). Trans. Am. Nucl. Soc., 6: 356(Nov. 1963).

2209 THE DEVELOPMENT OF SPHERICAL PYROLYTIC-CARBON-COATED UC_2 AND $(U,Th)C_2$ FUEL PARTICLES. H. G. Sowman, R. L. Surver, and J. R. Johnson (Minnesota Minning and Mfg. Co., St. Paul). Trans. Am. Nucl. Soc., 6: 380-2(Nov. 1963).

2210 COSTS OF FABRICATING UO_2/PuO_2 SWAGE-COMPACTED FUEL ELEMENTS. C. H. Bloomster and R. D. Widrig (General Electric Co., Richland, Wash.). Trans. Am. Nucl. Soc., 6: 395-6(Nov. 1963).

2211 SINTERING OF URANIUM DIOXIDE AT 900°C TO 1350°C. Drago Kolar and Velibor Marinković (J. Stefan Nuclear Inst., Ljubljana, Yugoslavia). p.65-70 of "Mining and Metallurgy Quarterly, No. 1, 1963." Translated from Rudarsko-Met. Zbornik, No. 1, 57-62(1963).

After sintering at 1350°C for two hours in an atmosphere of moist nitrogen, uranium dioxide, prepared by direct reduction of powder from ammonium diuranate (ADU) achieves 97% of the theoretical density. The electron micrographs of fractured surfaces show initial neck growth below 900°C and extensive grain growth after prolonged sintering at 1350°C. The decomposition of ADU to U_3O_8 sharply decreases the specific surface area of the powder; the initial linking of the grains into chain-like agglomerates accounts for the favorable density after prolonged sintering at 1350°C. Powder with a similar low specific surface area, prepared from uranyl nitrate, does not show the phenomenon of initial neck growth and sinters only up to 80% of the theoretical density. (auth)

2212 REMOTE FABRICATION OF BRAZED STRUCTURAL JOINTS IN RADIOACTIVE PIPING. E. C. Hise, F. W. Cooke, and R. G. Donnelly (Oak Ridge National Lab., Tenn.). New York, American Society of Mechanical Engineers, 1963, Preprint Paper 63-WA-53, 10p, $1.00. (CONF-102-15)

From American Society of Mechanical Engineers 1963 Winter Meeting, Philadelphia, Nov. 1963.

Techniques and equipment are developed that permit the piping system of the molten-salt reactor to be remotely disconnected for component replacement and connected again with a high degree of integrity. In particular, the 82 Au–18 Ni (wt %) alloy is found to have excellent strength, corrosion resistance, and wetting characteristics for this application. Joints of this type are not expected to be significantly weakened during long-term service, since metallographic examination and hardness traverses indicate little change in the brazed joint up to 10,000 hr at 1200°F. Consistently sound joints are obtainable in the field as well as the laboratory, using induction heating of the brazed joint in an argon atmosphere. Mechanical equipment for cutting, machining, and positioning the pipe work is fabricated for carrying out these operations remotely. Pipe joints of this type can be evaluated by the immersed, pulse-echo, ultrasonic technique, and a modification of this technique seems possible for remotely inspecting such joints. (auth)

2213 ON THE WORKABILITY OF SAP-ISML WITH PARTICULAR REGARD TO EXTRUSION AND DRAWING OF THIN-WALLED TUBINGS. C. Belvedere. 42p. (CONF-306-1; EUR 428.i). (In Italian)

From the 10th Conference of Italian National Metallurgical Society, Naples, Sept. 1963.

The general characteristics, working schedule, and possibility of pratical employment of SAP are given, along with the essential results of research carried out on the pilot seal relating to the principal working operations of SAP-ISML: extrusion, drawing, and rolling. Special attention is given to the experimental results for the existing correlations among the principal extrusion variables and the characteristics of such material. Regarding present interest showed by tubings of SAP in the nuclear field, the characteristics and behavior are outlined during operation of the material, the production of which was improved. (P.C.H.)

2214 CERIUM MONOSULFIDE ARTICLES, METHOD OF MAKING SAME, AND COMPOSITION THEREFOR. Stephen P. Begany, Joseph C. Fisher, Jr., Lawrence M. Litz, and Herbert C. Quandt (to Union Carbide Corp.). U. S. Patent 3,109,745. Nov. 5, 1963. Filed June 1, 1960.

A method is given for forming articles of CeS for use as core materials in making hollow castings, particularly turbine blades with channels. The method comprises dip-casting CeS from a suspension thereof onto a metal core, e.g., a Mo or W wire, and sintering the resulting article at 1600 to 2100°C. The slurry consists of fine CeS particles in a mixture of a cement and a solvent. Suitable cements are silicone and epoxy resins, paraffin wax, and latex-based cements, and suitable solvents are benzene, toluene, acetone, and dry-cleaning naphtha. The best slurry composition is 1 to 3 parts by weight rubber cement, 6 to 10 parts dry-cleaning napththa, and 27 to 41 parts CeS. (D.L.C.)

Properties and Structure

Refer also to abstracts 3134 and 3240.

2215 (ASD-TDR-63-782) EFFECTS OF THERMAL-MECHANICAL PROCESSING VARIABLES ON SHORT-TIME 3000°F TENSILE PROPERTIES OF TUNGSTEN + 0.6 PERCENT COLUMBIUM ALLOY. Vincent DePierre and George Saul (Aeronautical Systems Div. Air Force Materials Lab., Wright-Patterson AFB, Ohio). July 1963. 34p. (AD-420591)

The effects of thermal-mechanical processing variables on short-time 3000°F tensile properties of tungsten + 0.6 percent niobium alloy were determined by correlating both tensile properties and thermal-mechanical variables with microstructure and cold work condition of this alloy. From these correlations the spread in 3000°F tensile and yield strength values (22,000 to 63,310 psi and 10,500 to 61,500 psi respectively) is attributed to variations in processing factors and time at 3000°F during tensile testing. The correlations also serve as a guide for processing the alloy and for evaluating the alloy suitability for 3000°F service application. (auth)

2216 (CONF-39-105) KINETICS OF THE MOLTEN ALUMINUM–STEAM REACTION BY THE LEVITATION METHOD. R. E. Wilson (Argonne National Lab., Ill.). Feb. 1963. Contract W-31-109-eng-38. 9p.

From American Nuclear Society 9th Annual Meeting, Salt Lake City, June 1963.

A method was developed for levitating small samples, and experiments were made at 1200°C and up to study the reaction of Al with steam. The results are plotted on a graph of amount of Al reacted vs time. The reaction at 1200 and 1300°C is best described by a cubic rate law due to the formation of a protective oxide film. Above 1400°C, the reaction becomes approximately linear with respect to time. At 1600°C and above, the Al ignited after a variable delay and burned to ~90% completion in steam. (D.L.C.)

2217 (CRFD-1154) INVESTIGATION OF ThO_2–UO_2 AS A NUCLEAR FUEL. S. V. K. Rao (Atomic Energy of Canada Ltd., Chalk River, Ont.). July 1963. 45p. (AECL-1785)

To evaluate the potential of ThO_2–UO_2 as a nuclear fuel, specimens with UO_2 contents from 2.7 to 19 wt % were irradiated in the Hydraulic Rabbit of the NRX Reactor. In these three-minute irradiations, the power output to produce central melting in the ThO_2–UO_2 sinters decreased as the UO_2 content increased from 5.4 to 19 wt %. The decrease was partly due to an associated increase in porosity with increasing UO_2 content in these particular specimens, but there was also a decrease in the thermal conductivity of the solid itself. The diametral and longitudinal expansions of the sheath were very similar to those previously observed with pure UO_2. No difference in ex-

pansion behavior between various compositions was observed, when allowance was made for the difference in thermal conductivity already deduced. Air-fired sinters exhibited more grain growth than comparable hydrogen-fired ones, but the sheath expansions were not significantly different. It appears that hydrogen-fired sinters with a UO_2 content of 5 to 10 wt % UO_2 behave in essentially the same manner as those of pure UO_2. Increasing the UO_2 content up to 19% results in a poorer performance, while extrapolation suggests that the performance would improve with the UO_2 content decreasing from 5 wt %. (auth)

2218 (DPST-63-74-9) HYDRIDE ORIENTATIONS AND MECHANICAL PROPERTIES OF THIN-WALLED ZIRCALOY TUBING. USAEC-AECL Cooperative Program Monthly Progress Report, September 1963. R. P. Marshall (Du Pont de Nemours (E. I.) & Co. Savannah River Lab., Aiken, S. C.). Oct. 1963. Contract AT(07-2)-1. 5p.

Studies are being made of the orientation of zirconium hydride platelets in thin-walled Zircaloy tubing. Results from stress orientation tests at 18,000 and 30,000 psi confirmed previously reported results at lower stress levels that indicated that the susceptibility to stress orientation of the hydride platelets varied widely between tubing from different fabrication processes. These tests completed the stress orientation tests on circumferential specimens with 50 ppm hydrogen. (M.C.G.)

2219 (EUR-463.e) MEASUREMENTS OF THE CONDUCTIVITY AND POLARIZABILITY OF U AND UC AT OPTICAL FREQUENCIES. P. Camagni, A. Cingolani, and A. Manara (European Atomic Energy Community. Nuclear Research Center, Ispra, Italy). 1963. 18p.

The electrical conductivity and polarizability of uranium and uranium carbide were measured at optical frequencies, by means of a technique based on the polarization of reflected light. Dispersion curves for both parameters were determined in this way for the region of the spectrum going from ~0.35 μ to ~2.8 μ. The results are systematic enough to justify a certain comparison between the electronic structures of the two materials. However, the present data refer to polycrystalline specimens; they need to be implemented by further research on single crystals of UC and U, before definite conclusions can be reached. Such work is now in progress, using the same experimental methods. (auth)

2220 (EURAEC-748) MECHANISMS OF DIFFUSION AND OF PRECIPITATION OF HYDROGEN IN ZIRCONIUM. Period covered: March 1, 1963 and May 31, 1963. (Bologna. Universita. Istituto di Fisica). Work Performed under United States–Euratom Joint Research and Development Program. Contract 051-62-11-RDI. 57p.

Studies were made on (1) the precipitation dynamics of hydrides by electron microscopy, (2) the structural characteristics of the developed oxides with reference to their effects on hydrogen absorption, (3) the diffusion dynamics of hydrogen in zirconium, and (4) low-temperature resistivity tests for dissolved hydrogen and hydrides. (D.L.C.)

2221 (GEAP-4315) GRAIN GROWTH OF UO_2. PART I. H. Hausner (European Atomic Energy Community and General Electric Co. Atomic Power Equipment Dept., San Jose, Calif.). Apr. 15, 1963. Work performed under United States–Euratom Joint Research and Development Program. Contract AT(04-3)-189. 49p. (EURAEC-871)

Grain growth in UO_2 pellets was studied between 1900 and 2600°C. The pellets were encapsulated in small vacuum-tight tungsten containers in an argon atmosphere. The grain size-time relationship could be expressed by an equation: $D^2 - D_0^2 = K \cdot t^m$. A low exponent, $m \cong 1/3$, was found in these experiments and is related to the type of UO_2 investigated. An activation energy of 65 kcal/mole was obtained for the grain growth process. The time exponent, m, increased with increasing temperature if the pellets were not contained in closed capsules but heated under an argon pressure of 1.5 atm. An interaction between tungsten and UO_2 could be observed at a temperature of 2600°C after prolonged heat treatment. (auth)

2222 (LADC-5907) THERMODYNAMIC PROPERTIES AND PHASE RELATIONSHIPS IN THE U–C SYSTEM AND SELECTED U–M–C SYSTEMS. John D. Farr and Melvin G. Bowman (Los Alamos Scientific Lab., N. Mex.). Oct. 16, 1963. Contract W-7405-eng-36. 19p. (CONF-206-3)

From Symposium on Carbides in Nuclear Energy, Harwell, Eng., Nov. 1963.

Results of phase and thermodynamic studies strongly suggest only small differences in stability for the different uranium carbides. Partial phase diagram studies are made on several U–M–C ternary systems. Studies of the U–Zr–C and the U–Nb–C system indicate improved physical properties and stability for (U,M)C solid solutions in some reactor fuel applications. A relatively large number of compounds of the type UMC_2 exist and may exhibit desirable properties as specific reactor fuels. For example, $UMoC_2$ does not hydrolyze and does not react with C to form UC_2. (auth)

2223 (LADC-5924) THERMAL CONDUCTIVITY AND ELECTRICAL RESISTIVITY OF UC, (U, Pu)C, AND PuC. J. A. Leary, R. L. Thomas, A. E. Ogard, and G. C. Wonn (Los Alamos Scientific Lab., N. Mex.). Oct. 15, 1963. Contract W-7405-eng-36. 16p. (CONF-206-4)

From Symposium on Carbides in Nuclear Energy, Harwell, Eng., Nov. 1963.

The thermal conductivities and electrical resistivities of nuclear carbides were determined at elevated temperatures. Replacement of uranium by plutonium in the carbide lattice reduces the thermal conductivity. However, the rate of increase in thermal conductivity with increasing temperature is greater for higher plutonium contents. On the basis of electrical resistivity, UC and $(U_{0.8}Pu_{0.2})C$ are principally metallic conductors, while single phase $PuC_{0.87}$ behaves as a semiconductor. The Lorenz number for UC (3.30×10^{-13} c.g.s. units) is constant over the temperature range 200–400°C. For $(U_{0.8}Pu_{0.2})C$, the value of 3.92×10^{-13} also remains constant. However, there is considerable variation in the Lorenz number of $PuC_{0.87}$ over this temperature range. In all cases, the Lorenz number is considerably larger than that calculated theoretically for pure electronic conduction. (auth)

2224 (NLCO-890(p.27-31)) TEXTURE GRADIENTS IN OIL-QUENCHED MARK V-B OUTER FUEL CORES. C. A. Powell and P. E. Henry (National Lead Co. of Ohio, Cincinnati).

Four uranium Mark V-B outer fuel cores, heated into the beta phase and quenched in oil, were examined for texture gradients in the longitudinal, tangential, and radial directions. G_2, G_3, and J data are tabulated, and plots of statistically combined G_3 values for the four fuel cores are presented. (auth)

2225 (NLCO-890(p.33-8)) EFFECTS OF PHOSPHORUS ON THE TENSILE PROPERTIES OF URANIUM. W. N. Wise (National Lead Co. of Ohio, Cincinnati).

The tensile properties of slightly enriched uranium metal with high phosphorus content are compared with the prop-

erties of normal uranium metal having a lower phosphorus content. (auth)

2226 (NMI-1258) FUNDAMENTAL AND APPLIED RESEARCH AND DEVELOPMENT IN METALLURGY. HIGH-TEMPERATURE PROPERTIES OF REFRACTORY ALLOYS. Final Report to the United States Atomic Energy Commission for the Period July 1, 1962 through June 30, 1963. A. L. Geary (Nuclear Metals, Inc., West Concord, Mass.). Sept. 17, 1963. Contract AT(30-1)-2784. 67p.

Results of work to develop refractory metal-base alloys for high-temperature reactor applications are described. Eleven alloy systems were investigated by means of hot-hardness and oxidation. Although all alloying additions improved hardness, only Ta–Re–W ternary alloys had outstanding hot-hardnesses when compared with wrought alloys already being investigated. None of the alloying elements investigated significantly improved oxidation resistance. Ta–Re–W and Ta–Ru–W ternary alloy compositions, which were selected on the basis of the hot-hardness test results, were arc-cast into 2-inch diameter ingots and extruded. In the extruded condition, these alloys have ultimate strengths at 1600°C which are two to three times those of commercial tantalum-base alloys. Ta–2 at. % Ru, Nb–2 at. % Re, and Nb–5 at. % Re alloys, which were initially investigated, were successfully rolled into strip and tested at temperatures up to 1600°C. Cold-rolling, if followed by a recrystallization anneal, does not influence the properties of Ta–2 at. % Ru. The Nb–Re alloys rolled at 1000°C exhibit improved high-temperature strengths as well as improved room-temperature ductility. (auth)

2227 (NP-13261(p.1-28)) THE PROPERTIES OF URANIUM AND ITS COMPOUNDS. D. K. Faurschou (Canada. Dept. of Mines and Technical Surveys. Mines Branch) and C. E. Makepeace (Eldorado Mining and Refining Ltd., Eldorado, Saskatchewan).

Selected physical, chemical, crystallographic and thermodynamic properties of uranium oxides, sulphides, nitrides, hydrides, and carbides and UFe_2 are presented. These properties were selected for their relevance to ferrous metallurgy. The possible behavior of uranium compounds in steel is discussed. This information is regarded as being of value in the planning and interpretation of research into the utilization of uranium as an alloying element or as an otherwise useful metallurgical agent in steel. A refined technique for electrolytic extraction of uranium compounds from steel is also discussed. (auth)

2228 (NP-13261(p.124-35)) URANIUM IN CAST IRONS. R. K. Buhr (Canada. Dept. of Mines and Technical Surveys. Mines Branch).

Uranium additions to low-sulfur, hypereutectic, grey cast iron and to 1% chromium cast iron markedly increase the as-cast tensile properties. Uranium additions to high-sulfur, hypereutectic, grey iron decrease tensile strength. In cast irons having normal sulfur contents, uranium addition has a disastrous effect on the tensile strength. (auth)

2229 (NP-13261(p.136-83)) URANIUM IN ALLOY STEELS. W. A. Morgan (Canada. Dept. of Mines and Technical Surveys. Mines Branch); R. F. Knight, C. E. Makepeace, J. K. Pargeter, D. E. C. King, and R. J. McClure (Eldorado Mining and Refining Ltd., Eldorado, Saskatchewan).

The results of a number of investigations of the influence of uranium in alloy steels are presented. Many facets of this broad field remain to be investigated, and in some cases only initial and, therefore, inconclusive results are available, making it impractical to review more than the direction of current research. An attempt was made to give general coverage to topics of major interest in the various categories of alloy steels. Uranium forms carbides that are stable up to at least 1230°C (2250°F). This is reflected in lowered as-quenched and tempered hardness when sufficient uranium is present to deplete the matrix of carbon. In austenitic stainless steel, uranium is an effective stabilizing element. Uranium has been shown to have no statistically significant influence on secondary hardness and to aggravate the degree of temper embrittlement. The wear resistance of tool steels modified with uranium awaits evaluation. Results of creep testing indicate that small additions of uranium are beneficial. In stainless steels, uranium adversely affects forgeability above 1010°C (1850°F), except in resulfurized grades. In resulfurized stainless and tool steels, uranium improves the morphology of the sulfides so as to benefit transverse tensile properties. (auth)

2230 (NP-13261(p.184-206)) MICROSTRUCTURE AND HARDNESS OF IRON–URANIUM AND IRON–CARBON–URANIUM ALLOYS. W. J. Wrazej (Canada. Dept. of Mines and Technical Surveys. Mines Branch).

Microscopical and hardness examinations and, in some cases, x-ray diffraction studies were carried out on small melts of iron–uranium and iron–carbon–uranium alloys in different conditions of heat treatment. Comparisons were made with uranium-free materials to determine the influence of uranium on microstructure and hardness. The influence of composition and heat treatment on the occurrence and appearance of uranium monocarbide, UC, and epsilon phase, UFe_2, were studied. (auth)

2231 (ORNL-3488(p.96-101)) NONAQUEOUS SYSTEMS AT HIGH TEMPERATURE. (Oak Ridge National Lab., Tenn.).

The heats of fusion and the heat capacities of the solids and liquids in the vicinity of the melting points were determined for a number of rare-earth trihalides. In measurements of the heat content of strontium chloride from 298 to 1200°K, a second-order transition was observed near 1000°K, which is ascribed to the occurrence of disorder in either the anion or cation lattice. Solutions of lanthanum, praseodymium, and neodymium metals in their molten tribromides were found to exhibit similar behavior to solutions in the trichlorides and triiodides, namely, gradually decreasing conductance by the metal solute, that is, increasing stability of the M^{2+} ion, in going from lanthanum to neodymium. Solutions of gadolinium, dysprosium, holmium, and erbium in their molten trichlorides behave irregularly both in regard to solubility and electrical conductance. A maximum in conductivity near 50 mole % MX_2 dissolved in MX_3, similar to that in the NdI_3–NdI_2 system, was found for $NdBr_3$–$NdBr_2$. Merely positive deviation from additivity occurs in $DyCl_3$–$DyCl_2$ as it does in $NdCl_3$–$NdCl_2$. This and the absence of the effect in $NdCl_3$–$SrCl_2$ and NdI_3–SrI_2 support an earlier explanation based on electron exchange between adjacent oxidation states (Nd^{3+}–Nd^{2+}, Dy^{3+}–Dy^{2+}). (auth)

2232 (TID-18374) THE CRYSTAL STRUCTURE OF $ScCd_3$. R. V. Schablaske, B. S. Tani, and M. G. Chasanov (Argonne National Lab., Ill.). Jan. 1963. Contract W-31-109-eng-38. 8p. (UAC-7259)

X-ray diffraction photographs of $ScCd_3$ were indexed on the basis of a hexagonal unit cell, with lattice constants $a_0 = 6.330$ to 6.324 ± 0.001 A and $c_0 = 4.853 \pm 0.001$ A. The calculated density for 8 atoms in the unit cell is 7.54

g/cm³, as compared with a measured density of 7.7 g/cm³. The structure is of the Mg_3Cd ($D0_{19}$) type, and the space group is $D^4_{6h}-P6_3/mmc$. Calculated and measured powder diffraction intensities are compared. Interatomic distances are given. Another intermediate phase, ScCd, was also found in the Sc–Cd system. (D.L.C.)

2233 (UCRL-10879) ANNEALING OF VACANCIES IN QUENCHED ALUMINUM–MAGNESIUM ALLOY. Alf Kenneth Eikum (California. Univ., Berkeley. Lawrence Radiation Lab.). Sept. 1963. Contract W-7405-eng-48. 35p.

Vacancy climb of prismatic helicoidal dislocations and prismatic dislocation loops in aluminum-5 wt.% magnesium was studied using transmission electron microscopy. From both bulk annealing and thin foil heating stage experiments, the magnesium-vacancy binding energy E_b was estimated to be 0.10–0.20 ev. Helices and loops appear to grow in thin foils just as they do in bulk specimens, which is possible if local vacancy supersaturation can be maintained around the climbing dislocations. Above 250°C, loop growth can be described by an activation energy, $E_{(i)} = 0.95 \pm 0.05$ ev, which leads to a value of E_b of about 0.10–0.20 ev. The estimated binding energy accounts for the supersaturation. Some of the observations indicate that helical dislocation turns can degenerate into loops, possibly accounting for the high density of columns of loops observed in quenched aluminum alloys. (auth)

2234 (UNC-5060) THERMODYNAMICS OF THE URANIUM–NITROGEN SYSTEM. P. E. Lapat and R. B. Holden (United Nuclear Corp. Development Div., White Plains, N. Y.). June 15, 1963. Contract AT(30-1)-3128. 27p.

A continuous vacuum balance technique was used to measure equilibrium decomposition pressures of U_2N_3 from 600 to 1100°C and N/U ratios from 1.7 down to the two-phase region UN + U_2N_3. Data were also obtained on UN at 1073°C and slightly hyperstoichiometric compositions. Some of the phase boundaries of the two nitrides were located. (auth)

2235 (CEA-tr-X-487) ETUDE DES PROPRIÉTÉS DES PLAQUES COMPOSITES ULTRA-ÉPAISSES ACIER INOXYDABLE-ACIER SPÉCIAL, PRÉVUS POUR RÉSISTER AUX PRESSIONS RENCONTRÉES DANS LES REACTEURS NUCLÉAIRES. (Study on Properties of Heavy-Section Stainless-Clad Plate for Reactor Pressure Vessels). H. Susukida and Y. Sakumoto. Translated into French from Tetsu To Hagane, 48: 628-30(1962). 17p. (Includes original, 3p.).

The characteristics of three composite plates–two Japanese and one American–were tested and compared. The base plates were an ASTM A 302 B special steel, and the cladding plates were an AISI 304 L austenitic stainless steel. The specific composition of the three steels was tabulated. The mechanical characteristics, weldability, carbon diffusion, and resistance to notch were determined. The adherence between base and cladding plate was determined by shearing and traction studies and by detection of internal faults. The study of carbon diffusion showed that this phenomenon can modify the corrosion resistance. Thermal treatments to improve the resistance to notch of the Mn–Mo steel were investigated. The adherence of the Japanese plates was stronger. (J.S.R.)

2236 (EURAEC-607) MECHANISMS OF DIFFUSION AND PRECIPITATION OF HYDROGEN IN ZIRCONIUM. Quarterly Report No. 1, December 1, 1962–February 28, 1963. (Bologna. Universitá. Istituto di Fisica "A. Righi."). Work Performed under United States–Euratom Joint Research and Development Program. 58p. (A translation)

The technique for direct observation of zirconium by transmission electron microscopy is described. Electropolishing solution and work conditions are reported. Using transmission electron microscopy, the phenomena of work-hardening by plastic machining starting from recrystallized samples was studied along with recovery and recrystallization phenomena, dislocation characteristics, martensitic transformation effects, and precipitation phenomena. By x-ray diffraction techniques, associated with metallographic observations, the following problems were studied: effect of the mechanical deformation on crystal size and perfection, phase studies with respect to hydrogen content, and rolling textures. A unit was constructed which allows of hydrogenations, dehydrogenations, and deoxidations being carried out simultaneously at various pressures and temperatures on zirconium samples. The preliminary results note hydrogenation behavior at 700 and 900°C. The hydrogenation and dehydrogenation times were determined. (N.W.R.)

2237 (EURAEC-729) FUNDAMENTAL STUDY ON SOME FORMS OF EMBRITTLEMENT AFFECTING WELDED JOINTS IN HIGH TENSILE STEEL. Quarterly Report No. 6, April 1, 1963 to June 30, 1963. (Societe Anomyme des Forges et Ateliers du Creusot, Le Creusot, France). Work Performed under United States–Euratom Joint Research and Development Program. 31p. (A translation).

Results are presented concerning the effects of Ar on the mechanical properties of welded steel joints. Other results are included concerning the effects of work hardening and small welding-cycle strains on brittleness, and the effects of cooling rates on welds in the case of steel sheets of varying thicknesses. Other work is reported on the relation between austenitic grain size and the impact strength in quenched steel, on the cracking sensitivity of steel, and on the effects of H_2 on quenched steel embrittlement. (J.R.D.)

2238 THE DISSOCIATION OF DISLOCATIONS IN THE FACE-CENTERED CUBIC STRUCTURE. L. J. Teutonico (Republic Aviation Corp., Farmingdale, N. Y.). Acta Met., 11: 1283-9(Dec. 1963).

A study was made of the dissociation of dislocations on the {111} plane of fcc crystals. Dislocations in both the (110) and (112) orientations were considered. To determine which dissociations are energetically favorable, the force between the partials in each of the possible splitting reactions was calculated. Results of the calculation are presented for various fcc elements (for each of which the anisotropy factor A is greater than unity) as well as for a series of fictional fcc materials for which A < 1. It was found that all dissociations into a pair of Shockley partials are energetically favorable. Each dissociation resulting in a Shockley partial and a Frank partial is energetically favorable for one of the two classes of fcc materials designated by A > 1, A < 1. The force between the Shockley partial and the Frank partial is always repulsive for one of these two classes of materials and attractive for the other; only in the case of isotropy (A = 1) is the force between the partials zero. For the dissociations that are energetically favorable, the widths of the split dislocations in the various fcc elements were computed. (auth)

2239 PRECIPITATION AND SUPERCONDUCTIVITY IN LEAD–ANTIMONY ALLOYS. J. D. Livingston (Gen-

eral Electric Research Lab., Schenectady, N. Y.). Acta Met., 11: 1371-3(Dec. 1963).

Superconducting magnetization measurements were made on Sb–Pb alloys to yield useful information on the mode and kinetics of precipitation. For alloys containing 1.3 wt % and 2.45 wt % Sb aged at room temperature or at 95°C, the upper critical field was found to decrease continuously with aging. This implies a continuous precipitation process. (P.C.H.)

2240 PLASTIC BEHAVIOR OF POLYCRYSTALLINE URANIUM BETWEEN 20°C AND –196°C. André Lemogne, Jean Morin, and Paul Lacombe (École des Mines, Paris). Compt. Rend., 257: 2032-5(Sept. 30, 1963). (In French)

Traction tests were used to study the effect of temperature between 20 and –196°C on the plastic behavior of polycrystalline uranium. The rupture stress and the elongation at rupture decrease when the temperature is lowered, but pass through a plateau, which marks the passage from intercrystalline to transcrystalline rupture. (tr-auth)

2241 ISOTHERMAL DIFFUSION OF RADIOACTIVE FISSION PRODUCTS OUT OF COATED FUEL PARTICLES. R. Fiocchi (CNEN, Milan and Università, Milan) and G. Pierini. Energia Nucl. (Milan), 10: 481-7(Sept. 1963).

The equations of fission product diffusion in coated fuel spheres were solved, and their solutions used to calculate the number of atoms which will have diffused out of a coated sphere at a given time. The diffusion of Xe^{133} and Kr^{85} was considered in the case of uranium dioxide particles coated with a material having the same diffusion coefficients, while correction factors were also determined for several different ratios of fuel and coating diffusion coefficients. (auth)

2242 TRANSIENT THERMAL DIFFUSIVITY TECHNIQUE FOR REFRACTORY SOLIDS. J. A. Cape, G. W. Lehman, and M. M. Nakata (Atomics International, Canoga Park, Calif.). J. Appl. Phys., 34: 3550-5(Dec. 1963).

A new technique for the measurement of the thermal diffusivity at high temperatures is described. The diffusivity is determined from the time interval separating two radial isotherms in a cylindrical specimen. The observations are made during the transient heating (or cooling) period. Measurements are reported on Ta, ZrC, and TiC in the temperature range 1300 to 1650°C. The data are in good agreement with diffusivities calculated from specific heat and steady-state thermal conductivity measurements. (auth)

2243 HIGH-TEMPERATURE HEAT CONTENT OF HAFNIUM. Donald T. Hawkins, Marc Onillon, and Raymond L. Orr (Univ. of California, Berkeley). J. Chem. Eng. Data, 8: 628-9(Oct. 1963).

High-temperature heat contents of hafnium were measured over the temperature range 298 to 1346°K, using a diphenyl ether calorimeter. The results are well represented by the analytical expression: $H_T^0 - H_{298.15}^0 = 5.607T + 0.911 \times 10^{-3}T^2 - 1753$. Smoothed values of the thermal properties of hafnium, $H_T^0 - H_{298}^0$, Cp, $S_T^0 - S_{298}^0$, and $(F_T^0 - H_{298}^0)/T$, were derived and are tabulated at even 100° intervals. (auth)

2244 LOW-TEMPERATURE MAGNETIC PROPERTIES OF SOME URANIUM OXIDES. M. J. M. Leask, L. E. J. Roberts, A. J. Walter, and W. P. Wolf (Clarendon Lab., Oxford and Atomic Energy Research Establishment, Harwell, Berks, Eng.). J. Chem. Soc., 4788-94(Oct. 1963).

The magnetic susceptibilities of UO_2, $UO_{2.1}$, U_4O_9, U_3O_7, and U_3O_8 at temperatures between 1.5 and 44°K were determined using an a-c inductance method. The susceptibility of U_3O_8 rises to a sharp maximum at 4.2°K, with smaller effects at 8 and at 25.3°K. The susceptibility of UO_2 reaches a maximum at 29°K and remains constant between 25 and 2°K. A maximum in the susceptibility-temperature plot for U_4O_9 at 6.4°K occurs also in the plots for $UO_{2.1}$ and U_3O_7 and appears to be primarily due to the inclusion of interstitial oxygen ions in the UO_2 lattice, independent of the precise nature of subsequent ordering effects. (auth)

2245 GLIDE SYSTEMS IN NIOBIUM SINGLE CRYSTALS IN THE RANGE 1400–2300°C. Bryan Harris (Cambridge Univ., Eng.). J. Inst. Metals, 92: Part 3, 89-92(Nov. 1963).

Optical goniometry and the x-ray back-reflection technique were used to investigate the gliding in tension of pure niobium crystals between 1400 and 2300°C. The metal was found to glide on {110}, {112}, and {123} planes in the ⟨111⟩ direction. Examples of glide on {112} and {123} planes were confirmed by studies of x-ray asterism. In other experiments this confirmation was not obtained, the asterism suggesting, instead, that glide traces were composed of slip on pairs of {110} planes. It seems possible that the orientation of the crystal partly determines the operative glide system. A single glide plane becomes active if it coincides with the plane of maximum resolved shear stress. If, however, there is no such coincidence, composite slip may occur on pairs of {110} planes in such a way that the resultant trace resembles a plane of higher indices. (auth)

2246 THE INFLUENCE OF WARM ROLLING UPON THE DUCTILE/BRITTLE TRANSITION TEMPERATURE OF α–URANIUM. J. Bolton and P. D. Tilbury (Atomic Weapons Research Establishment, Aldermaston, Berks, Eng.). J. Inst. Metals, 92: Part 3, 95(Nov. 1963).

Reactor-grade U, which had been hot-cross-rolled at 640°C to 80% reduction and vacuum annealed at 600°C to remove hydrogen, was subsequently given varying degrees of warm-cross-rolling at 250°C. The result of tensile tests (at a strain rate of 1.4×10^{-3}/sec) on the warm-rolled sheet showed that by increasing the warm-rolling reduction from 10 to 40% the transition temperature was lowered by ~60°C. (P.C.H.)

2247 GROWTH OF β AND α PHASES IN URANIUM–MOLYBDENUM ALLOYS. J. Lehmann and N. Azam (C.E.N. de Saclay, Gif-sur-Yvette, France). J. Nucl. Mater., 10: 73-89(Oct. 1963). (In French)

The mechanism of $\gamma + \beta$ and $\gamma \rightarrow \alpha$ transformations in the $(\beta + \gamma)$ and $(\beta + \alpha)$ phase fields in U–Mo alloys with 1-3.5 wt % Mo was studied using an electron microscope. It was found that coherent nuclei form, leading to a Widmanstätten precipitate. (P.C.H.)

2248 AN ELECTRON MICROSCOPE STUDY OF THE THERMAL OXIDATION OF NATURAL GRAPHITE. A. E. B. Presland and J. A. Hedley (International Research and Development Co. Ltd., Newcastle upon Tyne, Eng.). J. Nucl. Mater., 10: 99-112(Oct. 1963).

Transmission electron microscopy was used to study the localized modes of oxidation attack in graphite, including the effect of catalysts. Experiments are described using natural Madagascar flake graphite, which provides specimens suited to electron microscopy and whose microstructural characteristics are easier to interpret than those of synthetic graphite. In previous oxidation experiments no special effort was taken to maintain abnormally clean environmental conditions. Oxidation then occurred by a channelling mechanism associated with impurities that aggregated at cleavage steps and crystal edges. The purity of the oxidation environment was therefore improved by

stages and the basic oxidation mode unaffected by impurities or channeling was observed. Attack took place in an irregular manner at crystal edges and cleavage steps with occasional hexagonal pits occurring in the centers of flakes. Using the latter experimental conditions as a starting point, the catalytic effect resulting from the controlled addition of impurities was characterized by directly observing the oxidation process taking place inside the electron microscope. When the mobility of the catalyst is markedly reduced either by coating it and the surface of the graphite with a carbonaceous film or when using irradiated graphite, a different form of attack involving pitting occurs. (auth)

2249 THE EFFECT OF THERMAL TREATMENT ON THE METALLOGRAPHIC STRUCTURE OF BERYLLIUM AND DILUTE BERYLLIUM ALLOYS. G. V. T. Ranzetta and V. D. Scott (Atomic Weapons Research Establishment, Aldermaston, Berks, Eng.). J. Nucl. Mater., 10: 113-26 (Oct. 1963).

Electron microscopy and electron-probe microanalysis techniques were used to study the microstructure of beryllium and some dilute beryllium alloys. The effect of thermal treatment on the dissemination of impurities and alloying elements was investigated with particular reference to the mechanical properties of the metal at 600°C. In beryllium-iron alloys annealed to improve high-temperature ductility the structure was typified by the presence of large iron-containing grain-boundary precipitates, together with a more general segregation of iron to grain boundaries and other favorable sites. Some indication of solid-solution hardening in the system was apparent but no evidence of a precipitation-aging process was found. It is therefore suggested that the microstructure in the grain-boundary regions of the metal may be important in affecting the ductility and coherency of metal grains at high temperatures. Annealed beryllium–chromium alloys had good high-temperature ductility, which in this case may be associated also with the observed purification of the matrix. (auth)

2250 THE HIGH TEMPERATURE OXIDATION OF BERYLLIUM AND THE FATE OF BERYLLIUM CARBIDE INCLUSIONS. W. B. Jepson, J. B. Warburton, and B. L. Myatt (Atomic Energy Research Establishment, Harwell, Berks, Eng.). J. Nucl. Mater., 10: 127-33(Oct. 1963).

The attack of inclusions of beryllium carbide in beryllium during oxidation in gaseous atmospheres at elevated temperatures was investigated with a beryllium–0.14 wt % carbon alloy in which the carbon was isotopically labeled with C^{14}. Significant attack of the carbide inclusions occurs at 700°C in water vapor and in oxygen; little attack takes place when the beryllium is oxidized in carbon dioxide. The results are relevant to the possible role of carbide inclusions in promoting intergranular oxidation. (auth)

2251 THE EFFECT OF GRAIN SHAPE ON THE TENSILE PROPERTIES OF α URANIUM. D. M. R. Taplin and J. W. Martin (Oxford Univ., Eng.). J. Nucl. Mater., 10: 134-9(Oct. 1963).

Quenching and annealing procedures were devised that produce samples of natural uranium of similar grain size and metallurgical state, but of three different grain profiles. Tensile tests were carried out between 90 and 670°K, and the results indicate that the brittle ductile transition temperature is increased with increasing irregularity of grain profile. It is proposed that the increase is due to enhanced likelihood of crack nucleation for a given strain. (auth)

2252 AN ANALYSIS OF THE DIFFUSION OF FISSION GAS BUBBLES AND ITS EFFECT ON THE BEHAVIOUR OF REACTOR FUELS. G. W. Greenwood and M. V. Speight (Berkeley Nuclear Labs., Berkeley, Glos, Eng.). J. Nucl. Mater., 10: 140-4(Oct. 1963).

It is shown that small bubbles move in a way analogous to Brownian motion with an effective diffusion coefficient that is inversely proportional to their radius to the fourth power. The movement is relevant to the behavior of reactor fuels insofar as it enables small bubbles to coalesce and an estimate is made of the rate of coalescence. The process influences the spacing of bubbles and enables a more satisfactory estimate to be made of swelling in fissile materials. (auth)

2253 THE STRUCTURE OF HEAT-TREATED UO_2 CRYSTALS. M. J. Klein and A. A. Bauer (Battelle Memorial Inst., Columbus, Ohio). J. Nucl. Mater., 10: 147-53(Oct. 1963).

An initial examination of UO_2 crystals provided evidence for the presence of U_2N_3 and uranium impurity phases both of which could contribute to the substoichiometric O/U ratios present in the as-received condition. After heat treatments, the crystals were re-examined metallographically. All specimens were characterized by porosity and the absence of any metallographically detectable impurity phases. However, a difference was observed in pore sizes and distributions depending on the heating rate used. The results suggest that the observed porosity in the crystals is the result of the dissociation of U_2N_3 particles. From an analysis of the observed structures and the equilibrium forces invluencing porosity, the approximate strength of UO_2 crystals at 1900°C was deduced. (P.C.H.)

2254 SPECTROSCOPY OF POINT DEFECTS. M. Balkanski, E. DaSilva, and W. Nazarewicz (École Normale Supérieure, Paris). J. Phys., 24: 451-7(July 1963). (In French)

The absorption spectra of such impurities as oxygen, carbon, and nitrogen are studied in the silicon lattice. Molecular vibrations are obtained at 9, 12.2, and 10.6 μ respectively. High-density defects, created by irradiation with fast neutrons polarize the lattice and make it possible to observe direct photon-photon interaction. The infrared absorption spectra owing to single phonons are composed of bands at 488, 417, 331, and 140 cm^{-1}, corresponding to modes TO LO, LA, and TA respectively. The energies of TO, for example, are determined under high resolution at the point of maximum density of modes at Γ, L, W and X. They are 516.5 ± 1; 488.5 ± 1; 474 ± 1; and 447 ± 1 cm^{-1}. (auth)

2255 SOME PHYSICAL PROPERTIES OF PLUTONIUM. W. B. H. Lord (Atomic Weapons Research Establishment, Aldermaston, Berks, Eng.). Met. Rev., 8: 277-310(1963).

A review is presented on the main physical properties of Pu, and some of the theoretical problems set by its behavior are outlined. 87 references are included. (P.C.H.)

2256 ELECTROTRANSPORT IN METALS. John Verhoeven (Iowa State Univ., Ames, Iowa). Met. Rev., 8: 311-68(1963).

A review is presented on recent experimental and theoretical works on electrotransport in semiconductors and solid and liquid metals. Discussion on similarities between different theories is appended. 141 references are included. (P.C.H.)

2257 MECHANICAL PROPERTIES OF SOLID-LIQUID ML12 ALLOY CONTAINING RARE EARTHS. I. I.

Novikov, V. V. Tikhonova, F. S. Novik, and G. A. Korolkov (Moscow Inst. of Steel and Alloys). Metalloved. i Term. Obrabotka Metal., No. 9, 53-6(Sept. 1963). (In Russian)

Rare earth admixtures to ML12 (magnesium cast) steel enhance its solid-liquid state ductility and prevent crystallization cracking. Admixtures of La were most effective in improving the ductility and yield. (R.V.J.)

2258 EFFECTS OF ZIRCONIUM ON THE SIZE OF THE GRAIN IN MAGNESIUM ALLOY WITH 4.5% Zr. V. M. Babkin. Metalloved. i Term. Obrabotka Metal., No. 9, 56-7(Sept. 1963). (In Russian)

A maximum saturation of magnesium alloy with Zr is reached at 780 to 800°C, and a fine grain alloy is achieved with a minimum content of 0.6 to 0.75% Zr. (R.V.J.)

2259 SMALL-ANGLE SCATTERING BY PYROLYTIC GRAPHITE. R. H. Bragg (Lockheed Research Lab., Palo Alto, Calif.), M. L. Hammond, J. C. Robinson, and Paul L. Anderson. Nature, 200: 555-7(Nov. 9, 1963).

Data were obtained on small-angle scattering by pyrolytic graphite. The results indicate that small-angle scattering is due to voids in the pyrolytic graphite. The voids are nearly as numerous as the crystallites in pyrolytic graphite and are probably pyramidal-shaped crevices having inertial distances roughly 22 by 44 A normal and parallel respectively to the mean orientation of the sheets of crystallites. The results also imply a very high density of crack nuclei in pyrolytic graphite. (P.C.H.)

2260 URANIUM DIOXIDE-CLADDING INTERACTIONS. AXIAL EXPANSION OF UO_2 COLUMN IN FUEL ELEMENTS. C. N. Spalaris (General Electric Co., San Jose, Calif.). Nucl. Sci. Eng., 17: 381-91(Nov. 1963).

Irradiation experiments were conducted to determine the axial expansion of UO_2 in fuel elements. The experiments included fuel segments with 304 stainless and Zircaloy-2 sheaths in self-supporting tubular geometries under boiling water conditions, as well as fuel elements with 304 stainless UO_2-supported geometries under superheated steam conditions. The relative UO_2 expansion during irradiation was measured by mechanical devices included in the fuel segments and by visual and other observations. (auth)

2261 EFFECTS OF INITIAL MATERIAL ADMIXTURES ON REFRACTORY PROPERTIES OF FABRICATED ZIRCONIUM DIOXIDE. N. I. Voronin, V. S. Gorodetskii, and E. I. Khavkin (All-Union Inst. of Refractory Materials, USSR). Ogneupory, No. 1, 30-5(1963). (In Russian)

Studies were made of the influence of Fe, Al, Ti, Si, and P oxides on sintering, hardness, thermal stability, deformation under load, linear expansion, and microstructure of objects fabricated from ZrO_2 stabilized by calcium. Industrial, high-quality refractory ZrO_2 should be free of admixtures, especially P, Fe, and Si oxides. (R.V.J.)

2262 ON THE STABILIZATION AND SINTERING OF HIGH-PURITY ZIRCONIUM DIOXIDE. D. N. Poluboyarinov, G. P. Kalliga, and L. A. Lyutsareva (Mendeleev Chemical and Technological Inst., USSR). Ogneupory, No. 4, 175-9(1963). (In Russian)

Stability, sintering, and properties of sintered 99.5% pure ZrO_2 (0.1 HfO_2 and 0.4% other admixtures) were studied. Stabilization was carried out with 4 to 15 mole % CaO or MgO. Complete sintering was reached following a 5-hr annealing at 1710°C. The highest stabilization was reached with 10 mole % of stabilizing oxide. Increased amounts of stabilizer (12 to 15 mole %) reduced the density and thermal stability, while increased annealing temperatures to 2200°C did not affect the density. (R.V.J.)

2263 WORK-HARDENING IN NIOBIUM SINGLE CRYSTALS. T. E. Mitchell, R. A. Foxall, and P. B. Hirsch (Cambridge Univ., Eng.). Phil. Mag. (8), 8: 1895-1920(Nov. 1963).

The work-hardening properties of niobium single crystals grown by electron-beam zone-melting were investigated over a wide range of purities, orientations, temperatures, and strain-rates. Three stages of hardening are observed after the onset of plastic flow. The initial flow stress decreases with increasing purity, increasing temperature, and decreasing strain-rate. In stage I the work-hardening rate θ_I is low and increases with increasing temperature and decreasing strain-rate. The extent of stage I is a maximum at ~273°K and stage I is absent for multiple slip orientations. In stage II the work-hardening rate θ_{II} is high and is approximately independent of temperature above 295°K. The work-hardening rate θ_{II} is greater for multiple slip orientations and also increases with increasing purity. In stage III the work-hardening rate decreases continuously until fracture. Stage III is more prominent at high temperatures and the stress at the onset of Stage III, τ_{III}, decreases with increasing temperature. Slip-line observations show that slip occurs initially on (011) planes and that in stage II bands of secondary slip occur. The nature of the slip lines observed in stage I is compatible with the view that some cross-slip of screw dislocations occurs and that edge dislocations slip much further than screws. (auth)

2264 RESISTIVITY AND THERMOELECTRIC POWER OF CARBIDES OF THORIUM, URANIUM, AND PLUTONIUM. P. Costa and R. Lallement (Centre d'Études Nucléaires, Fontenay-aux-Roses, France). Phys. Letters, 7: 21-2(Oct. 15, 1963). (In French)

2265 THE MAGNETIC PROPERTIES OF PRASEODYMIUM METAL. B. Bleaney (Univ. of Pittsburgh). Proc. Roy. Soc. (London), Ser. A, 276: 39-50(Nov. 5, 1963).

The magnetic properties of praseodymium metal are interpreted in terms of a simple model suggested by the crystal structure where alternate layers of ions are subjected to crystal fields of face-centered cubic and hexagonal symmetry. The crystal field parameters are found by fitting the magnetic specific heat anomaly, and the variation of the susceptibility with temperature can be explained using a two-parameter molecular field model. The exchange interaction is predominantly ferromagnetic in sign. The origin of the hyperfine specific heat is discussed, and attributed to interaction effects, though these must be larger than can be accounted for by simple theoretical estimates. (auth)

2266 ELECTRON CORRELATION AND FERROMAGNETISM OF TRANSITION METALS. Junjiro Kanamori (Osaka Univ.). Progr. Theoret. Phys. (Kyoto), 30: 275-89(Sept. 1963).

The electron correlation in a narrow energy band is discussed taking into account the multiple scattering between two electrons. The discussion is an adaptation of Brueckner's theory of nuclear matter. It is assumed that electrons interact with each other only when they are at the same atom. The effect of the electron correlation depends in an intricate way on the energy spectrum of a given band. An approximate expression of the effective magnitude of the interaction is derived. The condition for the occurrence of ferromagnetism is investigated for various types of bands. The ferromagnetism of Ni and the paramagnetism of Pd can be understood reasonably through the present approach. The degeneracy of the d bands is taken into account in the discussion of these metals. (auth)

2267 IMPROVED METHOD OF ELECTRICAL CONTACT TO CERAMICS FOR HIGH TEMPERATURE USE. J. F. Bacon and R. D. Veltri (United Aircraft Corp., East Hartford, Conn.). Rev. Sci. Instr., 34: 1264-5(Nov. 1963).

A flame-sprayed metallic coating was used to establish satisfactory contact to the ceramic of which the electrical resistivity was of interest. Some typical specimens are shown. Measurements on the electrical resistivity of strontium zirconate as a function of temperature are given. (R.E.U.)

2268 BERYLLIUM: EFFECT OF ULTRA-HIGH PRESSURE ON RESISTANCE. Arnold R. Marder (Wright Aeronautical Div., Curtiss-Wright Corp., Wood-Ridge, N. J.). Science, 142: 664(Nov. 8, 1963).

Beryllium, subjected to a pressure of 93 kb at 25°C, undergoes a change in structure, as indicated by a 45-percent decrease in resistance. At 55 kb a small change in the resistance-pressure relationship suggests another modification of the usual hexagonal-close-packed structure. (auth)

2269 ELECTRICAL PROPERTIES OF SINGLE CRYSTALS OF URANIUM DIOXIDE. P. Nagels, M. Denayer, and J. Devreese (SCK-CEN, Mol, Belg.). Solid State Commun., 1: 35-40(June 1963).

Electrical conductivity measurements between 90 and 900°K were performed on single crystals with composition $UO_{2.000}-UO_{2.007}$. The activation energy decreases from 0.34 to 0.19 ev with increasing excess oxygen content. Hall effect measurements yielded no measurable response (Hall mobility $\mu_H < 0.015$ cm^2 V^{-1} sec^{-1} at 300°K). The results can be interpreted on the basis of small polaron theory. (auth)

2270 ROTATION OF SPINS IN HEXAGONAL COBALT. E. F. Bertaut, A. Delapalme, and R. Pauthenet (Centre d'Études Nucléaires, Grenoble, France). Solid State Commun., 1: 81-4(Sept. 1963). (In French)

The spin rotation, mainly due to the thermal variation of the anisotropy constants K_1 and K_2, and the thermally induced polydomain structure in hexagonal cobalt are directly checked by neutron diffraction. (auth)

2271 THE $\alpha-\delta$ TRANSFORMATION IN PLUTONIUM. W. M. Lomer (Atomic Energy Research Establishment, Harwell, Berks, Eng.). Solid State Commun., 1: 96-8 (Sept. 1963).

The $\alpha-\delta$ phase transformation in Pu–5% Ce seems to be martensitic. A correspondence matrix is proposed that relates the lattices and accounts for most of the atomic positions. (auth)

2272 COMPATIBILITY OF NPD FUEL WITH FUEL-HANDLING EQUIPMENT. J. Pawliw (Canadian General Electric, Petersborough, Ont.). Trans. Am. Nucl. Soc., 6: Suppl., 1-2(Oct. 1963).

2273 CUTTING AND REMOVAL OF A DAMAGED CONTROL ROD BASKET AT THE SM-1 NUCLEAR POWER PLANT. Garrett V. Sidler, Charles R. Feavyear, and John C. Bouldin ([Army Engineer School,] Engineer Reactors Group, Fort Belvoir, Va.). Trans. Am. Nucl. Soc., 6: Suppl., 3-4(Oct. 1963).

2274 CORRELATION OF FAILURE OF ESH-1 SUPERHEAT FUEL CLADDING WITH STRAIN CYCLING FATIGUE DATA. V. E. Hazel, G. F. Rieger, and C. N. Spalaris (General Electric Co., Cincinnati). Trans. Am. Nucl. Soc., 6: 328-9(Nov. 1963).

2275 THE DIFFUSION OF NON-VOLATILE METALLIC ELEMENTS IN GRAPHITE. James R. Wolfe, Donald R. McKenzie, and Richard J. Borg (Univ. of California, Livermore). Trans. Am. Nucl. Soc., 6: 354-5(Nov. 1963).

2276 EFFECT OF HYDROGEN AND HYDRIDE MORPHOLOGY ON THE TENSILE PROPERTIES OF ZIRCALOY-2. W. J. Babyak, W. F. Bourgeois, and G. J. Salvaggio (Westinghouse Electric Corp., Pittsburgh). Trans. Am. Nucl. Soc., 6: 369-70(Nov. 1963).

2277 DUPLEX-CARBON-COATED FUEL PARTICLES. R. A. Reuter (National Carbon Co., New York). Trans. Am. Nucl. Soc., 6: 380(Nov. 1963).

2278 SELECTED PROPERTIES OF SOME THORIUM/URANIUM COMPOUNDS. N. M. Griesenauer, J. A. De Mastry, and F. A. Rough (Battelle Memorial Inst., Columbus, Ohio). Trans. Am. Nucl. Soc., 6: 391(Nov. 1963).

2279 INTERMEDIATE PHASES IN IRON–ZIRCONIUM SYSTEMS. V. N. Svechnikov, V. N. Pan, and A. Ts. Spektor (Inst. of Metal Physics, Academy of Sciences, USSR). Zh. Neorg. Khim., 8: 2118-23(Sept. 1963). (In Russian)

Intermediate phases of Fe–Zr alloys were investigated and constitution diagrams of equilibrium phases were constructed considering the $ZrFe_3$ compound which was found at 1480°C. The compound developed according to a peritectic reaction had a cubic face-centered lattice with a = 11.667 kX (1.169056 nm) parameter and about 112 atoms in the elementary cell. (R.V.J.)

2280 CONSTITUTION DIAGRAM OF YTTRIUM–TIN ALLOYS. V. F. Terekhova, I. A. Markova, and E. M. Savitskii. Zhur. Neorgam. Khim., 8: 1991-3(Aug. 1963). (In Russian)

Thermal, microstructure, and x-ray analyses were made of the Y–Sn system, and a constitution diagram was constructed with 30, 40, 70, and 90 at. % Sn. It was shown that tin solubility in solid yttrium does not exceed 1 wt % Sn and maximum yttrium solubility in tin is 0.3 wt %. (R.V.J.)

2281 INTERSOLUBILITY OF ZIRCONIUM, NIOBIUM, AND HAFNIUM CARBIDES. E. I. Gladyshevskii, N. M. Popova, and T. F. Fedorov. Zhur. Neorgan. Khim., 8: 1997-8(Aug. 1963). (In Russian)

Phase studies of the ternary ZrC–NbC–HfC system showed that it forms continuous solid solutions. The phase composition and crystalline lattice constants for the system are tabulated and microstructure of 45 mole % ZrC, 55 mole % NbC is shown. (R.V.J.)

2282 CONSTITUTION DIAGRAM FOR PRASEODYMIUM–NEODYMIUM ALLOYS. I. A. Markova, V. F. Terekhova, and E. M. Savitskii. Zhur. Neorgan. Khim., 8: 1998-2000(Aug. 1963). (In Russian)

Constitution diagrams for Pr–Nd alloys exhibited hexagonal low-temperature α modifications and high-temperature β modifications from continuous solid solutions of these metals. (R.V.J.)

2283 OXIDATION OF NIOBIUM AND ITS LOW CARBIDE SYSTEMS. S. I. Alyamovskii, G. P. Shveikin, and P. V. Gel'd. Zhur. Neorgan. Khim., 8: 2001-4(Aug. 1963). (In Russian)

Intermediate oxidation products of Nb and NbC were analyzed using powdered and 3mm specimens of Nb, NbO, NbO_2, $NbC_{0.8}$, and Nb_2C heated for 3 hrs at 300°C. X-ray pictures taken of NbO_2, NbO, and $NbC_{0.80}$ oxidation exhibited sharp lines for the respective phases, while Nb_2C showed split, washed out lines with 101, 110, 112 indices. Spectral compositions of Nb_2C and $NbC_{\sim 0.4}$ are practically identical. The Nb_2C structure is also identical to the U_2C structure with elementary nucleus a = 5.00_4 kX, b = 4.57 kX, and c = 2.89_7 kX. (R.V.J.)

2284 ION-BOMBARDMENT ETCHING OF NUCLEAR MATERIALS. Boris Navinšek, Velibor Marinković, and Viktor Kraševec (J. Stefan Nuclear Inst., Ljubljana, Yugoslavia). p.71-6 of "Mining and Metallurgy Quarterly, No. 1, 1963." Translated from Rudarsko-Met. Zbornik, No. 1, 63-8(1963).

Ion-bombardment etching of nuclear materials is discussed and methods are described. Results are presented for Al, Cu, UO_2, Cd, U, U–Mo alloy, and stainless steel. (M.C.G.)

2285 TEMPERATURE DEPENDENCE OF THE CRITICAL CURRENT OF TANTALUM AND INDIUM–TIN ALLOY FILMS. W. H. Meiklejohn (General Electric Research Lab., Schenectady, N. Y.). 10p. (CONF-301-2)

From International Conference on the Science of Superconductivity, Hamilton, N. Y., Aug. 1963.

The measured temperature dependence of the critical current near T_c of some cylindrical tin films agrees with the theoretical prediction of $(1-t^2)^{\frac{1}{2}}$. However, the measured temperature dependence of the critical current of some tantalum films and indium-tin alloy films show an increased temperature dependence over the theoretical result. The 1000 Å tantalum films had a temperature dependence proportional to $(1-t^2)^{2.3}$ over four orders of magnitude of current and down to 0.4 T_c. The exponent of the temperature dependent term $(1-t^2)$, for the indium-tin alloy thin films increased from 1.5 for pure tin to about 3 for the 3% indium alloy. The results may indicate that impurity scattering changes the temperature dependence of the bulk critical field or the penetration depth from that of pure superconductors. (auth)

2286 PARAMETRIC EFFECTS GOVERNING THE MECHANICS OF CERAMIC MATERIALS. N. A. Weil (Cummins Engine Co., Inc., Columbus, Ind.). 50p. (CONF-135-4)

From International Symposium on High Temperature Technology, Asilomar, Calif., Sept. 1963.

After a brief treatment of the theories on strength and causes of fracture in brittle materials, research findings on the effects of prior thermal history, atmospheric environment, strain rate, microstructure and grain size, repeated mechanical loading, impurities, porosity, and stress gradient on the strength of ceramics are reviewed. Multicrystalline substances of magnesia, alumina, and beryllia are emphasized. Statistical strength theories are also summarized. 75 references. (D.C.W.)

2287 EFFECT OF TRANSITION METAL IMPURITIES ON THE CRITICAL TEMPERATURE OF NON-TRANSITION METALS. G. Boato, G. Gallinaro, and C. Rizzuto (Università, Genoa). 5p. (CONF-301-12)

From International Conference on the Science of Superconductivity, Hamilton, N. Y., Aug. 1963.

Measurements were made on Al–Mn, Al–Fe, Al–Cr and Zn–Mn dilute alloys. It was found that the depression of Tc caused by the impurities in Zn is about hundred times larger than that in Al. This is ascribed to the formation, in zinc, of localized magnetic states. (auth)

2288 SPECIFIC HEAT MEASUREMENTS AND PROXIMITY EFFECTS IN TIN–LEAD EUTECTIC ALLOYS. C. A. Shiffman, J. F. Cochran, M. Garber, and G. W. Pearsall (Massachusetts Inst. of Tech., Cambridge). 13p. (CONF-301-4)

From International Conference on the Science of Superconductivity, Hamilton, N. Y., Aug. 1963.

The heat capacity of Pb–Sn alloys was compared with the sum of the heat capacities of its parts measured in bulk form. The specific heat of the alloys was measured from 1.8 to 8°K in zero field giving C_s and in a field of 1450 gauss giving C_n. The measured specific heat was overwhelmingly dominated by the lattice contribution. It was concluded from the results that there is a genuine proximity effect in the eutectic alloy. The results also suggest that as the temperature is lowered the effective thickness of the lead region is gradually increased by one tin mean free path. (P.C.H.)

2289 EFFECT OF FORMULATION ON GRAPHITE STRENGTH. Robert B. Trask (Speer Carbon Co., Niagara Falls, N. Y.). 14p. (CONF-73-20)

From 6th Biennial Conference on Carbon, Pittsburgh, June 1963.

An analysis was made of the contributions of particle size distribution and pitch level to graphite flexural strength. Forty-two formulations with a coarse filler fraction varied in six increments from 0 to 40%, fine fractions varied from 60 to 100%, and three pitch-binder concentrations were extruded into rods of 5-inch diameter. These rods were baked to 750°C, graphitized at constant rate to 2750°C, sampled, and tested for flexural strength. Rods representing each formulation also were pitch impregnated after baking, were rebaked and graphitized along with the unimpregnated bars. An accurate prediction of strength based on particle size distribution alone was not possible because of pitch concentration effects. Graphite strength was correlated statistically with the amount of residual carbonized pitch and with the percent of volume change during baking. (auth)

2290 IMPROVEMENTS IN OR RELATING TO MAGNESIUM BASE ALLOYS. Edward Frederick Emley (to Magnesium Elektron Ltd.). British Patent 941,804. Nov. 13, 1963. Filed Oct. 18, 1960.

Processes for producing fine-grained wrought Mg–Zr alloys with excellent creep ductility and good grain growth resistance at high temperature are described. Zirconium in alloy billets is precipitated as hydride by heat treatment in a hydrogenous atmosphere before extrusion. Homogenization heat treatments in a nonhydrogenous atmosphere before extrusion give stiffer alloys. Be, Mn, and rare earths can be incorporated in the alloys; specific compositions, processes, and properties are discussed. (D.C.W.)

Radiation Effects

Refer also to abstract 3083.

2291 (BNL-6836) INTERSTITIAL-SINK REACTIONS IN NEUTRON-IRRADIATED GRAPHITE. II. STORED ENERGY CORRELATIONS. Donald G. Schweitzer and Robert M. Singer (Brookhaven National Lab., Upton, N. Y.). [1962]. Contract AT(30-2)-Gen-16. 18p.

Low temperature stored energy releases in alternately irradiated and 350°C annealed graphites showing an increase in macroscopic expansion rate after initial exposures exceeding ~1000 Mwd are the same as in graphites exhibiting normal expansion rates. Reverse stored energy annealing experiments are correlated with the reverse c-axis annealing described in other work. The assumption that interstitials anneal to sinks rather than to vacancies can be used to explain these data. The nature of the annealing reactions producing stored energy releases is discussed. (auth)

2292 (CRFD-1156) CRACKING AND BULK MOVEMENT IN IRRADIATED URANIUM OXIDE FUEL ELE-

MENTS. A. S. Bain (Atomic Energy of Canada Ltd., Chalk River, Ont.). Sept. 1963. 40p. (AECL-1827)

UO_2 pellets were fabricated with simulated circumferential or diametral cracks, and with voids formed by drilling axial or radial holes. Under irradiation the cracks healed in a region extending out slightly beyond the area of discernible grain growth. Cracks in the cooler outer annulus formed early and remained during the irradiation. Similarly voids in the outer annulus were unchanged, whereas those in the grain-growth region closed. W wire markers stayed in their original positions, demonstrating that the surrounding columnar grains in the UO_2 had not formed during the solidification of a melt. Decreases in diameter of 1 mm thick Zircaloy-2 sheathing assembled with large fuel/sheath diametral clearances were due to multi-axial stresses arising from axial elongation and the lack of diametral restraint. (auth)

2293 (FZK-161-1) INVESTIGATION OF COMBINED EFFECTS OF RADIATION AND VACUUM AND OF RADIATION AND CRYOTEMPERATURES ON ENGINEERING MATERIALS. VOLUME I. RADIATION-VACUUM TESTS. Annual Report, November 9, 1961–November 8, 1962. E. E. Kerlin (General Dynamics/Fort Worth, Tex.). Jan. 5, 1963. Contract NAS8-2450. 340p. (N63-21066)

Tests were performed to measure the combined effects of nuclear radiation and vacuum on a group of nonmetallic materials that are considered for use in nuclear-powered space vehicles. This group consisted of materials classified as adhesives, seals, thermal insulations, electrical insulations, potting compounds, dielectric materials, lubricants, structural laminates, and thermal-control coatings. Typical tests performed on material specimens included lap-shear strength, ultimate tensile strength, ultimate elongation, stress-strain characteristics, compressive strength, weight loss, lubricity, color changes, and spectral reflectivity. Two vacuum systems having pumping speeds in excess of 3000 l/sec at 10^{-6} torr were designed and built for use in these irradiations. Special dynamic test equipment was built for testing materials in vacuum after irradiation. Measured properties of the materials as a function of integrated neutron flux and gamma dose are reported, and recommendations for use of the various materials in nuclear-powered spacecraft are made. (auth)

2294 (HW-SA-2953) DAMAGE IN MOLYBDENUM ASSOCIATED WITH NEUTRON IRRADIATION AND SUBSEQUENT POST-IRRADIATION ANNEALING. T. K. Bierlein, H. E. Kissinger, B. Mastel, and J. J. Laidler (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Mar. 14, 1963. Contract AT(45-1)-1350. 13p.

Molybdenum foil discs containing <10, 100 to 200, and 400 to 500 ppm carbon were irradiated at 40°C to exposures as high as 10^{19} nvt. The microstructures and x-ray diffraction patterns of the irradiated specimens were then studied. The results show that irradiation of cold-worked or annealed molybdenum results in the formation of point defects, cold-working introduces trapping centers which prevent the clustering of defects formed during irradiation, large loops form only the molybdenum containing carbon, and irradiation increases the x-ray lattice parameter and line breadth, the increase being greatest for the higher carbon contents. (D.L.C.)

2295 (JPL-TR-32-518) SOME EXPERIMENTAL AND THEORETICAL SIGNIFICANCES ASSOCIATED WITH IRRADIATED PROPELLANT. Anthony San Miguel and Edward N. Duran (California Inst. of Tech., Pasadena. Jet Propulsion Lab.). Nov. 1, 1963. 15p.

The mechanical properties of polyurethane solid propellant are degraded significantly by irradiation dosages greater than 10^6 rads. Four mechanical tests that provide sufficient data to characterize the degradation are described. These tests consist of (1) swelling, (2) torsion, (3) uniaxial tension, and (4) multiaxial tension and compression. The experimental data are characterized in terms of average molecular weight between cross-links (M_c), percent sol, small-strain shear modulus, tension modulus, and strain energy for increasing irradiation dosage. Comparisons between the various test data provide insight into the underlying effects of mechanical property degradation. Conclusions obtained in this study indicate that (1) the usefulness of M_c is questionable with regard to defining ionizing radiation degradation in a composite propellant such as polyurethane, (2) the torsion test is a simple and expedient method that may be used to study irradiated propellant quantitatively, (3) certain aspects of the kinetic theory of rubber elasticity are not quantitatively applicable to polyurethane propellant, and (4) the degradation response of irradiated propellant obtained from a uniaxial tension test typifies the degradation response of irradiated propellant obtained from multiaxial tests. (auth)

2296 (NP-13163) EFFECT OF NUCLEAR RADIATION ON MATERIALS AT CRYOGENIC TEMPERATURES. Quarterly Progress Report No. 10, April 1963–June 1963. (Lockheed-Georgia Co., Marietta, Ga.). Contract NASw-114. 24p. (ER-6383)

Preparation for the in-pile screening test program continued with test loop and transfer system carriage assembly modification. Remote tool fabrication was continued. Transfer system pre-neutron procedures and test specimen changing were performed with quadrant "D" drained. The final material selected for out-of-pile and in-pile screening tests in an austenitic manganese alloy steel. Other materials previously selected include alloys of Al, Ni, Ti, and steel. (M.C.G.)

2297 (REIC-27) THE EFFECT OF NUCLEAR RADIATION ON CERAMIC REACTOR-FUEL MATERIALS. James B. Melehan, Victor W. Storhok, Richard J. Burian, Mihkel Kangilaski, and Richard A. Wullaert (Battelle Memorial Inst. Radiation Effects Information Center, Columbus, Ohio). June 30, 1963. Contract [W-7405-eng-92]. 84p.

State-of-the art information is presented on the effects of nuclear radiation on ceramic reactor fuel materials that are being used or being considered for use in various types of reactors. The materials discussed include uranium oxides, uranium carbides, uranium mononitride, uranium silicides, plutonium oxide, and plutonium carbide. Data are presented in the form of tables and curves for physical damage incurred by the fuel materials as a result of their exposure to nuclear radiation. (auth)

2298 THE EFFECT OF HEATING RATE AND NEUTRON IRRADIATION ON THE SPECIFIC HEAT BEHAVIOR OF A Cu–16.8 AT. % Al AND A Cu–17.2 AT. % Ga SOLID SOLUTIONS. C. R. Brooks and E. E. Stansbury (Univ. of Tennessee, Knoxville). Acta Met., 11: 1303-12(Dec. 1963).

The effect of heating rate on the specific heat behavior of binary solid solutions of copper containing 16.8 at. % Al and 17.2 at. % Ga in the range 40–700°C was investigated. Also the effect of prior neutron irradiation on the specific heat behavior of the Cu–Al alloy was studied. The specific heats were measured with a dynamic adiabatic cal-

orimeter. An anomalous behavior in the specific heat was observed in both solid solutions that is explained in a consistent manner based on the presence of short-range order. The initial slow cooling at approximately ½°C/min from above about 330°C leaves the alloys prior to reheating with short-range order present. Upon reheating the kinetics of disordering are such that disordering does not begin until about 200°C. The specific heat then shows an anomalous rise of about 7% then decreases slightly around 300°C. From about 300 to 700°C the heating rates employed (½–7°C/min) are low enough to allow instantaneous equilibrium to be established. The specific heats remain anomalously high at least to 700°C. The specific heat curves in the region from 200 to 300°C shift to higher temperatures with increased heating rate. Neutron irradiation at 100°C after slow cooling increased the amount of short-range order present and also introduced excess vacancies. The additional short-range order caused an increase in the specific heat curve as compared to just slow cooling, since more order is destroyed. Due mainly to the excess vacancies the anomalous behavior was observed at lower temperatures than for just slow cooling. (auth)

2299 CHANGES IN THE SURFACE CONDUCTIVITY OF THE POLYVINYL CHLORIDE PRODUCT "TROVIDUR" AFTER X-IRRADIATION WITH 1 TO 70 MEGARADS. L. Wojtech and K. Heuss (Max Planck-Institut für Biophysik, Frankfurt am Main). Atompraxis, 9: 404-8(Oct. 1963). (In German)

The electric surface conductivity of the polyvinyl chloride plastic Trovidur was measured following energy doses of 1 to 70 megarads. A high-output x-ray machine served as the radiation source. At a relative moisture content of 75%, surface conductivity following irradiation was changed by 6 powers of 10 in comparison with the maximum before irradiation. The surface-conductivity value of a non-irradiated sample was 10^{-14}ohm^{-1} at a distance of 1 cm, with a measurement surface of 1.2 cm^2 and a test tension of 1000 volts. The relative change in surface conductivity varied with time, depending upon the dose, but only up to the 25th day. After that, it remained constant for the rest of the measurement period (75th and 150th day). In addition, constant values were also found following doses of more than 25 megarads, so that it was impossible to increase surface conductivity by applying larger doses. The increase in surface conductivity is interpreted as being the result of hydrophilization of the surface and of the formation of hydrogen chloride resulting from irradiation. Thus, the latter was traced quantitatively following doses between 28 and 130 megarads. Thirty days after irradiation the formation of hydrogen chloride was practically complete, and there was a linear connection between the total amount of hydrogen chloride developed and the dose. From this, a G value of 5.7 was determined. (auth)

2300 THE EFFECT OF NEUTRON IRRADIATION ON THE CORROSION BEHAVIOR OF ALUMINUM IN WATER. A. V. Byalobzheskii (Inst. of Physical Chemistry, Academy of Sciences, USSR). Dokl. Akad. Nauk SSSR, 152: 899-900 (Oct. 1, 1963). (In Russian)

It had been shown previously that irradiation of Al by 0.8 Mev electrons had led to the formation of a thick oxide film in a 3% NaCl solution, and that this thick oxide film dissolved more readily in the salt solution than the thin oxide film of an unirradiated control. On irradiating an Al sample with a total integrated neutron flux of 10^{20}n/cm^2, it was found that an oxide film 15 to 16 μ thick was formed when placed in hot water at 96°C. The unirradiated control sample showed no oxide film with a magnification of 200 under the microscope. The oxide films were separated from the samples in boric acid, and subjected to x-ray analysis. The irradiated sample showed the presence of gibbsite (α-$Al_2O_3 \cdot 3H_2O$) with a small amount of boehmite (γ-$Al_2O_3 \cdot H_2O$). Only pure boehmite could be detected in the unirradiated control sample. The corrosion rates were 0.01 g/m^2/hr for the irradiated Al, and 0.004 g/m^2/hr for the unirradiated Al. The results show that neutron irradiation changes the structure of the oxide film, and accelerates the corrosion of Al by allowing water to penetrate the oxide film through defects resulting from the irradiation. (TTT)

2301 DIODES TOLERATE HIGH RADIATION. David Navon (Transitron Electronic Corp., Wakefield, Mass.). Electronics, 36: No. 48, 48-50(Nov. 29, 1963).

Developments in diodes with combined low capacitance and fast switching speeds are discussed. Research has found that above and beyond the basic design considerations, the diode resistance can be increased several hundred percent by using silicon starting material with improved radiation tolerance. (P.C.H.)

2302 NUCLEAR RADIATION EFFECTS CONFERENCE, IEEE SUMMER GENERAL MEETING, TORONTO, ONTARIO, CANADA, JUNE 16-21, 1963. IEEE (Inst. Elec. Electron. Engrs.), Trans. Nucl. Sci., NS-10: No. 5, 1-176 (Nov. 1963).

Twenty articles are included; separate abstracts were prepared for 9. The remaining 11 articles were previously abstracted in NSA and include information on pulsed and steady state radiation effects on magnetic materials, glass coated silicon transistors, transistors, semiconductor devices, solar cells, radar receiver components, insulating materials, capacitor dielectrics, and digital switching circuits and the design and test of a tolerant servo amplifier. (P.C.H.)

For abstracts of individual papers see: 2303, 2304, 2305, 2306, 2307, 2308, 2309, 2310, and 2311.

2303 RADIATION EFFECTS IN DIAMOND LATTICE SEMICONDUCTORS. J. H. Crawford, Jr. (Oak Ridge National Lab., Tenn.). IEEE (Inst. Elec. Electron. Engrs.), Trans. Nucl. Sci., NS-10: No. 5, 1-10(Nov. 1963).

Developments in the study of diamond-lattice semiconductors are reviewed and basic results that may contribute to the development or choice of devices for use in radiation environments are pointed out. Special attention is given to radiation effects in germanium and silicon. It was concluded that the annealing stages in high-purity n-type germanium can be understood on the basis of defect-impurity interactions of a nature similar to those known to occur in silicon. The formation of D-V and D-V_2 complexes can be inferred from the behavior of the various annealing stages. (P.C.H.)

2304 MECHANISMS OF TRANSIENT RADIATION EFFECTS. V. A. J. van Lint (General Atomic Div., General Dynamics Corp., San Diego, Calif.). IEEE (Inst. Elec. Electron. Engrs.), Trans. Nucl. Sci., NS-10: No. 5, 11-19(Nov. 1963).

The mechanisms of transient radiation effects are discussed by separating the processes into consecutive steps, beginning with the interaction of nuclear radiation with a particular atom in the target material, which leads to an ionization process. The subsequent history of the liberated electron is then traced to its eventual thermalization and recapture. Some of the important manifestations of free electrons, including the emission of secondary electrons

from surfaces, conduction in ionized gases, excess-carrier effects in semiconductors, conduction processes in insulators, and some of the optical effects of excited and free electrons are also discussed. A number of rules of thumb that have been developed for estimating approximately the magnitude of transient radiation effects in a given material are given. (P.C.H.)

2305 RADIATION STUDIES ON GaAs AND Si DEVICES. Joseph J. Wysocki (RCA Labs., Princeton, N. J.). IEEE (Inst. Elec. Electron. Engrs.), Trans. Nucl. Sci., NS-10: No. 5, 60-5(Nov. 1963).

GaAs and Si n/p cells were irradiated with 100-kev and 17.6-Mev protons, and 0.8- and 5.6-Mev electrons. The resulting difference in performance was interpreted in terms of the initial lifetime and the photo-absorption process. It was concluded that GaAs cells can deliver a given power longer than Si cells in a radiation field of high-energy protons and electrons. Thin shields will be required for both cells in environments of low-energy protons. It is suggested that the recombination centers introduced in silicon by high-energy particles are more effective than those introduced by 0.8-Mev electrons. (auth)

2306 PROTON-NEUTRON DAMAGE EQUIVALENCE IN Si AND Ge SEMICONDUCTORS. J. R. Bilinski, E. H. Brooks, U. Cocca, and R. J. Maier (General Electric Co., Syracuse, N. Y.). IEEE (Inst. Elec. Electron. Engrs.), Trans. Nucl. Sci., NS-10: No. 5, 71-86(Nov. 1963).

Following an analysis of the basic radiation damage processes in semiconductors, and an analysis of existing radiation effects data, a proton-neutron damage equivalence was experimentally determined for silicon solar cells. The basis for comparison is the degradation of minority carrier lifetime during irradiation, as expressed by the lifetime damage constant, K_τ, or the diffusion length damage constant, K_L. Both p on n cells and n on p cells were irradiated with 96, 69, and 48 Mev protons, and with fission and moderated neutrons. Measurements were made on the degradation of the solar cell dark voltage-current characteristics, the forward bias characteristics under one sun illumination, and the short circuit current response to monochromatic illumination of one micron wavelength. The degradation of minority carrier diffusion length was calculated from the short circuit current response at one micron. From the analysis of radiation damage processes in silicon, the derivation of a theoretical proton-neutron damage equivalence was hindered by inadequately developed theory relating the number and type of active defects associated with the vacancies created by the incident particles. The analysis of available data indicate that a reliable proton-neutron damage equivalence in Si or Ge is not possible, due to the spread in the existing damage constants and the absence of damage constants for proton and neutron irradiations of equivalent samples. The experimentally determined proton to neutron ratio of minority carrier diffusion length damage constants in silicon solar cells range from 0.96 to 4.7, depending on p or n type silicon, proton energy, and neutron spectrum. The minority carrier lifetime damage in silicon solar cells produced by 100 Mev protons is approximately the same as that produced by fission neutrons. The damage produced by moderated neutrons is somewhat less. (auth)

2307 EFFECTS OF SIMULATED TRANSIT RADIATION ON DIGITAL CIRCUITS. Donald A. Courtois (Bendix Corp., Ann Arbor, Mich.). IEEE (Inst. Elec. Electron. Engrs.), Trans. Nucl. Sci., NS-10: No. 5, 87-92(Nov. 1963).

Results of tests made to determine the performance of digital computer circuits in a transit radiation environment are described. The transit radiation is emitted by airborne weapon fission products after the fireball and cloud column have dispersed. The transit radiation was simulated by use of cobalt-60 gamma radiation to a maximum dose rate of 3×10^5 roentgens/hour and to a maximum dose of 1.5×10^4 roentgens. The circuits tested consisted of conventional transistor digital circuitry with 11 to 32 components mounted on each printed wire card. A total of 72 cards of twelve types were actively tested using the manufacturer's acceptance specifications as a basis for determining proper performance. Circuit performance was recorded by photographing the oscilloscope display of circuit waveforms at regular intervals during a test. As a result of the radiation measurable changes occurred in the output waveforms of some of the circuits, but in no instance did the circuit performance become unacceptable because of the radiation. (P.C.H.)

2308 RADIATION TOLERANT MAGNETIC AMPLIFIER. M. Frank, F. W. Poblenz, and D. W. Howard. IEEE (Inst. Elec. Electron. Engrs.), Trans. Nucl. Sci., NS-10: No. 5, 93-103(Nov. 1963).

Several operational magnetic amplifier stages of low and medium power levels were designed and tested in a nuclear radiation environment to levels of 1×10^{18} neutrons/cm^2 (E > 0.1 Mev) and were found to exhibit acceptable performance. Various diode characteristics were obtained under radiation to correlate behavior with amplifier designs. Diode test results are presented for irradiations at three different reactor facilities. (auth)

2309 PULSED RADIATION EFFECTS ON THYRATRON TUBES. F. C. Tietze (IBM Corp., Owego, N. Y.). IEEE (Inst. Elec. Electron. Engrs.), Trans. Nucl. Sci., NS-10: No. 5, 139-48(Nov. 1963).

The results of early experiments to characterize the firing of thyratron tubes by intense pulses of nuclear radiation were reexamined in the light of recent experimental results. Evidence is presented that the tube is fired by gas ionization rather than a radiation induced grid voltage transient. Plate voltage was observed to be an important determinant of the firing criteria. A significant time delay also was found to exist between the radiation stimulus and the firing of the tube. General guidelines are presented for designing circuits that are more resistant to the effects of pulse radiation. (P.C.H.)

2310 CHARGE-CONTROL EQUIVALENT CIRCUIT FOR PREDICTING TRANSIENT RADIATION EFFECTS IN TRANSISTORS. C. Rosenbery (Boeing Co., Seattle), D. S. Gage, R. S. Caldwell, and G. H. Hanson. IEEE (Inst. Elec. Electron. Engrs.), Trans. Nucl. Sci., NS-10: No. 5, 149-58 (Nov. 1963).

A charge-control equivalent circuit that can be used with a computer to predict the time-dependent response of any transistor to a pulse of ionizing radiation is described in detail. Operation of the equivalent circuit during saturation is also provided. Measurement procedures are described for each of the necessary parameters in the circuit and comparison with experimental flash x-ray data is presented. Use of this transistor representation is demonstrated for predicting the response of a complete transistorized amplifier circuit. (auth)

2311 DIGITAL COMPUTER TECHNIQUES FOR DETERMINING CIRCUIT BEHAVIOR IN A PULSED NUCLEAR ENVIRONMENT. W. E. Craig and H. W. Mathers (IBM Corp., Owego, N. Y.). IEEE (Inst. Elec. Electron. Engrs.), Trans. Nucl. Sci., NS-10: No. 5, 168-76(Nov. 1963).

Two digital computer circuit analysis programs that predict circuit response in a pulsed nuclear radiation environment are presented. One program requires that linear direct current equations be written manually and then programmed for computer solution. The other program generates the equations from topological circuit information and then solves the equations during the radiation burst automatically. Predictions generated by the sutomated program on four different circuits were verified experimentally. (auth)

2312 RADIATION EFFECTS IN GaAs. L. W. Aukerman, P. W. Davis, R. D. Graft, and T. S. Shilliday (Battelle Memorial Inst., Columbus, Ohio). J. Appl. Phys., 34: 3590-9(Dec. 1963).

Comparison of the annealing properties of radiation-induced conductivity changes in GaAs indicates that about 10% of the damage created by reactor irradiations anneals in a manner quite similar to but not identical with that created by 1-Mev electrons. The remaining neutron damage requires much higher annealing temperatures and is presumed to result from complicated damage structures characteristic of highly energetic knock-on atoms (e.g., disordered regions). Heavy neutron irradiation of either p- or n-type GaAs results in very high resistivities which appear to be influenced by the presence of slow surface states. Energy levels resulting from neutron irradiation are estimated to lie at approximately 0.1 and 0.5 ev below the conduction band and at 0.6 ev above the valence band. Moderate irradiation of GaAs by fast neutrons gives rise to a continuous optical absorption spectrum for wavelengths beyond the fundamental absorption edge, with the absorption increasing as the inverse square of the wavelength. Similar behavior occurs in CdTe and CdS after neutron irradiation. Although this effect is not well understood, it is suspected of being associated with defect structures characteristic of fast neutron bombardment, since heavy bombardment with electrons does not produce the same behavior. (auth)

2313 RADIATION-INDUCED CAVITIES AND EXFOLIATION. William Primak (Argonne National Lab., Ill.). J. Appl. Phys., 34: 3630-1(Dec. 1963).

Interferometric observation of surface rise and pitting depth was made for sapphire, spinel, rutile, and peridot after bombardment by protons or helium at 100 to 140 kev. The surfaces were protected from sputtering by a coating. (R.E.U.)

2314 DISLOCATION CHANNELING IN NEUTRON-IRRADIATED MOLYBDENUM. B. Mastel, H. E. Kissinger, J. J. Laidler, and T. K. Bierlein (General Electric Co., Richland, Wash.). J. Appl. Phys., 34: 3637-8(Dec. 1963). (HW-SA-3105)

Carbon-containing molybdenum foils were exposed to 10^{19} neutrons per cm^2 (E > 1 Mev) at 40°C. Transmission electron microscopy was used to investigate the dislocation channeling produced. (R.E.U.)

2315 ELECTRICAL AND THERMAL PROPERTIES OF ELECTRON-BOMBARDED SILVER SELENIDE POWDERS. A. S. Epstein (Monsanto Chemical Co., St. Louis). J. Appl. Phys., 34: 3641-2(Dec. 1963).

Measurements of the electric resistivity, Seebeck coefficient, and thermal conductivity were made initially and immediately following a bombardment by 2-Mev electrons at room temperature for 352 minutes. Conventional measuring techniques were used. (R.E.U.)

2316 THE OBSERVATION OF COLLISION SEQUENCES IN UO_2. R. S. Nelson (Atomic Energy Research Establishment, Harwell, Berks, Eng.). J. Nucl. Mater., 10: 154-6(Oct. 1963). (AERE-R-4283)

The focusing of momentum by collision sequences was examined in UO_2 by means of high energy ion bombardment. The structure of UO_2 is regarded as a simple fcc arrangement of uranium with oxygen positioned at the eight equivalent positions ($\frac{1}{4},\frac{1}{4},\frac{1}{4}$). As in the fcc structure, the simplest sequence in UO_2 is expected to propagate along the (110) directions. Under the hard-sphere conditions, focusing occurs when the collision radius R becomes sufficiently large to satisfy the condition $R \geq \frac{1}{4}D^{110}$, and so successive collisions occur before the midway points. Focusing in the (100) directions of fcc metals results from the interaction with rings of atoms surrounding the sequence. Focusing in the (111) direction of a fcc structure results from the interaction with a pair of converging lenses; in UO_2 successive uranium atoms in this direction are separated by pairs of oxygen atoms. The results suggest that focusing in UO_2 occurs predominantly in the (110) and (100) directions, together with rather weak focusing in the (111) directions. (P.C.H.)

2317 TRANSMISSION ELECTRON MICROSCOPE STUDY OF IRRADIATION EFFECTS IN SINTERED URANIUM DIOXIDE. A. D. Whapham and B. E. Sheldon (Atomic Energy Research Establishment, Harwell, Berks, Eng.). J. Nucl. Mater., 10: 157-62(Oct. 1963). (AERE-R-4306)

The irradiation of pre-thinned sintered uranium dioxide produced fission fragment tracks ~100 Å wide. Black spots, thought to be point defect clusters, lie along the tracks. Bulk material (0.13 mm discs), when irradiated and subsequently thinned, did not show tracks. Neutron irradiation also increased the electrical conductivity of uranium dioxide. After a dose of 10^{17} nvt the conductivity increased to 5×10^4 ohm cm. However, after a post-irradiation anneal in vacuo ($10^{-5} - 10^{-6}$ torr) at 700°C for 1 hr, the resistivity was restored to its unirradiated value. After such an anneal prior to thinning, material that had been irradiated in bulk to a dose of 10^{17} slow nvt and 7×10^{17} slow nvt did not show any visible radiation damage. (P.C.H.)

2318 RADIATION EFFECTS ON SEMICONDUCTORS. Pierre Baruch (École Normale Supérieure, Paris). J. Phys., 24: 458-64(July 1963). (In French)

A review is given of radiation-induced defects in semiconductors and about their influence on properties of these materials. Recent work has shown the importance of interactions between these defects and impurities, other defects, or electron population. Such interactions modify the structure, stability, and effects of radiation defects. Specific examples of such effects are discussed, in the case of germanium, silicon, and intermetallic compounds. (auth)

2319 EFFECT OF FAST NEUTRONS ON THE THERMAL CONDUCTIVITY OF GERMANIUM AND SILICON. Nguyen Van Dong, M. Vandevyver, and Pham Ngu Tung (Centre d'Études Nucléaires, Saclay, France). J. Phys., 24: 464-6(July 1963). (In French)

Germanium and silicon crystals are irradiated with fission neutrons to integrated fluxes of 1.2×10^{18} cm^{-2}. The thermal conductivity of the samples is measured before and after irradiation as a function of temperature between 80 and 300°K. In the whole of the temperature range, the thermal conductivity decreases with respect to that measured before irradiation. The results are interpreted from the shape of the curves of the additional thermal resistivity. (auth)

2320 EFFECTS OF PROTON IRRADIATION ON THE PROPERTIES OF SILICON. A. Authier (Laboratoire de Minéralogie-Cristallographie, Sorbonne, France). J. Phys., 24: 467-70(July 1963). (In French)

The diffusion enhancement is studied in high-temperature proton-irradiated silicon crystals, revealed by the displacement of an n-p junction. The defects created by irradiation are studied. The whole thickness of the crystal may be perturbed. The perturbation disappears after etching away of the region where the defects are created, 10 μ from the surface (depth of penetration of the protons). (auth)

2321 EVOLUTION OF DEFECTS INTRODUCED BY NEUTRON IRRADIATION IN A SILICON P-I-N JUNCTION. J. C. Lanore, J. M. Combes, and R. Schuttler (Centre d'Études Nucléaires, Fontenay-aux-Roses, France). J. Phys., 24: 471-3(July 1963). (In French)

The variation of the physical parameters in a P.I.N. junction under neutron irradiation, and their evolution by annealing, are studied. An activation energy of 0.5 ev is obtained. (auth)

2322 IRRADIATION OF METALS. R. M. Walker (Faculté des Sciences, Paris). J. Phys., 24: 474-81 (July 1963). (In French)

It is shown that the simple threshold theory of damage gives an excellent description of the major features of irradiation induced changes provided the energy of recoil atoms is quite low. As the energy of the recoil atoms increases, the agreement with theory becomes worse. The simple theory also does not take into account the role of crystal structure in the propagation of energy and interstitials atoms. The importance of such lattice effects is demonstrated experimentally and attempts are made to calculate them both analytically and numerically. Recently electronic calculators are used to follow in detail the motion of many atoms after one atom is given an initial kinetic energy. Such calculations, performed at both low and high recoil energies, give a detailed picture of the damage process. It is not known how well these calculated pictures correspond to the situation in a real crystal. With the single exception of Au, all pure metals that are electron-irradiated at low temperatures show a recovery of more than 75% of the irradiation induced changes following a thermal treatment in the range 4 to 100°K. Recovery processes at higher temperatures are complicated by the interaction of the radiation-induced defects with preexisting crystal defects such as dislocations and impurity atoms. Such defect interactions are apt to be important even in the purest metals available. The major low-temperature peak is generally attributed to the motion of interstitial atoms. There is another intrinsic recovery peak in metals, which in copper occurs close to room temperature. The identification of the defect responsible for this peak is still a matter of controversy. Not much is yet known about the detailed atomic configuration of any of the point defects. A development is the direct observation of clusters of irradiation-induced defects by transmission electron microscopy. This technique appears to hold considerable promise for the future both in the resolution of some of the problems concerning point-defects and in the study of the properties of the clusters themselves. (auth)

2323 DEFECTS CREATED BY IONIC BOMBARDMENT OF THIN CRYSTALS OF GOLD. B. Jouffrey (Faculté des Sciences, Orsay, France). J. Phys., 24: 482-8(July 1963). (In French)

The effects of ion bombardment on thin evaporated crystals of gold are investigated by means of the electron microscope. These effects are a function of the temperature of the sample. At room temperature the main effect is the production of a great number of dislocation loops. Elongated loops are observed. The behavior of these defects during annealing shows that these elongated loops are dipoles, which appear to be perfect. At 200°C the ion bombardment produces new defects, which appear to be argon bubbles. It is possible to observe the condensation of bubbles on to the dislocation loops. (auth)

2324 EFFECTS OF WEAK IRRADIATIONS ON URANIUM. Y. Quéré (Centre d'Études Nucléaires, Fontenay-aux-Roses, France). J. Phys., 24: 489-98(July 1963). (In French)

After recalling the model for the action of fission fragments on uranium, results are given dealing with length and resistivity measurements after low-temperature moderate irradiation. Resistivity data may be understood if it is supposed that point defect clusters are annihilated in displacement spikes, the volume of which ($\nu_2 \simeq 0.9 \times 10^{-16}$ cm^3) seems practically independent of temperature. Point defects should then be subject to recombination in larger temperature-dependent fission spikes, ν_1. If a whole spectrum of volumes $\nu_1 \ldots \nu_n$ is introduced, the results are not greatly modified. (auth)

2325 RADIATION EFFECTS ON GRAPHITE. A. Herpin (Centre d'Études Nucléaires, Saclay, France). J. Phys., 24: 499-502(July 1963). (In French)

Irradiated graphite has very particular properties: incomplete annealing at low temperature, accompanied with a strong freeing of energy, and complete annealing at high temperature. An attempt at explanation is made, based on the evolution of interstitials, which can form more or less important groups. (auth)

2326 MAGNETIC TRAINING IN PURE AND DOPED NEUTRON-IRRADIATED IRON. Pierre Moser and Daniel Dautreppe (Centre d'Études Nucléaires, Grenoble, France). J. Phys., 24: 516-21(July 1963). (In French)

The basis of the magnetic after-effect is described, as well as the main information that can be deduced from the measurements: activation energy; concentration; and anisotropy of the defects. Five magnetic after-effect zones are found on pure iron irradiated at 78°K with neutrons. A model is proposed for the defects responsible for these zones. The effect of small amount of nickel is studied. (auth)

2327 STUDY OF THE ANNEALING OF DEFECTS IN AN IRON–NICKEL ALLOY, BY POST-IRRADIATION DETERMINATION OF THE MAGNETIC ANISOTROPY. Jean Paulevé and Daniel Dautreppe (Centre d'Études Nucléaires, Grenoble, France). J. Phys., 24: 522-4(July 1963). (In French)

A uniaxial magnetic anisotropy is induced by neutron bombardment with an applied magnetic field in Fe–Ni (50%-50%) samples. This anisotropy is caused by a new order-disorder transition. After an irradiation at 30°C, the annealing of the defects is studied by means of the magnetic anisotropy increase. In most cases the law $\Delta E = a \log (bt + 1)$ is verified very well. This law can be explained by a second-order reaction for the annealing of the defects. After an irradiation at 78°K an isochronal annealing indicates that the defects that give rise to an enhancement of the diffusion process begin to move only at 100°K. The interstitials do not seem to contribute to the ordering process. (auth)

2328 EFFECT OF DEFECTS PRODUCED BY NEUTRON BOMBARDMENT ON THE EXCITON SPECTRUM OF Cu_2O. S. Nikitine and M. Grosmann (Université, Strasbourg). J. Phys., 24: 525-31(July 1963). (In French)

Samples of cuprous oxide are irradiated with fast neutrons. The modifications of the exciton spectrum observed are similar to those produced by an electric field applied to the crystal. The irradiation probably produces charged defects, which produce an internal electric field. The evaluation of this field allows an evaluation of the concentration of defects produced by the irradiation. (auth)

2329 STRUCTURE AND PROPERTIES OF LITHIUM FLUORIDE FOLLOWING LOW-TEMPERATURE NEUTRON IRRADIATION. M. Lambert and A. Guinier (Faculté des Sciences, Orsay, France). J. Phys., 24: 552-60(July 1963). (In French)

Defects that appear at room temperature in low-temperature-irradiated crystals are different from the defects observed in crystals that are irradiated in-pile without any temperature control. The total number of defects, given by density measurements, is higher in the former case. As soon as the irradiation temperature is higher than −12°C, crystals behave as high-temperature-irradiated ones. In order to obtain the same properties a low-temperature-irradiated crystal has to be heated at a temperature above 325°C. (auth)

2330 THE MAGNETIC SUSCEPTIBILITY OF LITHIUM FLUORIDE SINGLE CRYSTALS IRRADIATED BY THERMAL NEUTRONS. A. Van Den Bosch (CENSCK, Mol. Belg.). J. Phys., 24: 569-70(July 1963). (In French)

The susceptibility can be explained as composed of three parts: the diamagnetic part of a normal LiF matrix; a temperature-dependent paramagnetic part following the Curie law, owing to unpaired electrons; and a temperature-independent paramagnetic part owing to metallic lithium. (auth)

2331 DISLOCATION LOOPS IN IRRADIATED IRON. B. C. Masters (Berkeley Nuclear Labs., Gloucestershire, Eng.). Nature, 200: 254(Oct. 19, 1963).

Thin foils of iron (approximately 1000 Å thick) were irradiated with protons and Fe^+ ions of energy 150 kev at temperatures in the range 20 to 600°C. Dislocation loops produced had diameters ranging from 50 Å at low temperatures to 1500 Å at higher temperatures. The projected shape of the loops was elliptical in the proton-irradiated foils and lozenge shaped in the foils irradiated with Fe^+ ions. A full crystallographic analysis was made for loops produced by irradiation with Fe^+ ions to a total dose of $\sim 1.7 \times 10^{16}$ ions/cm^2 at a rate of $\sim 4 \times 10^{14}$ ions/cm^2 sec at 500–600°C. All the observed loops were found to be square, lying on (100) planes with sides in the (100) directions. (P.C.H.)

2332 NEUTRON-SPECTRA CALCULATIONS FOR RADIATION-DAMAGE STUDIES. R. E. Dahl and H. H. Yoshikawa (General Electric Co., Richland, Wash.). Nucl. Sci. Eng., 17: 398-403(Nov. 1963). (HW-SA-2864)

Fast-neutron spectra were computed using three different codes: GNU-II, HFN, GE-HAPO-S-X. Significant differences in spectra were seen as codes with varying degrees of refinement were used. GE-HAPO-S-X was chosen for calculating cross section values and testing damage models because of its greater accuracy and wider applicability. The calculations illustrate spectral differences existing at different points in a reactor lattice. The spectra are used to compute relative activation for such fast-neutron flux monitor materials as Ni^{58}, Fe^{54}, and Am^{243} and to calculate gross vacancy production using widely varying damage models. From the results it was concluded that calculation of spectra in irradiation facilities is necessary for the proper reduction of monitor activities to neutron exposures and for correlation of observed radiation effects in materials irradiated in dissimilar facilities. (auth)

2333 OBSERVATION OF DAMAGE REGIONS IN n-TYPE GERMANIUM BY MEANS OF A CHEMICAL ETCH. M. Bertolotti (Università, Rome), T. Papa, D. Sette, V. Grasso, and G. Vitali. Nuovo Cimento (10), 29: 1200-4 (Sept. 1, 1963).

An atempt was made to observe radiation damage regions in n-type germanium by means of chemical etches. The crystals were irradiated with 14-Mev neutrons with an integrated flux of 5×10^{12} n cm^{-2}. Enriched CP-4 etch was used and electron micrographs of the etches are shown. (C.E.S.)

2334 RECOVERY OF ALUMINUM AFTER NEUTRON-IRRADIATION AT 78°K. S. Ceresara (Istituto Sperimentale Metalli Leggeri, Novara, Italy), T. Federighi, D. Gelli, and F. Pieragostini. Nuovo Cimento (10), 29: 1244-61 (Sept. 16, 1963).

Zone-refined Al and 99.995% purity Al samples were irradiated at liquid-nitrogen temperature at fast (>1 Mev) neutron doses of 1.4×10^{18} and 2×10^{17} n/cm^2. The recovery of radiation damage, as revealed by electrical resistivity, takes place mainly in two stages, indicated as stage I_n-2 and I_n-3, centered respectively at −150 and at −60°C. Stage I_n-2, controlled by an activation energy of about 0.3 ev, is sensitive to the impurity content and was ascribed to the release of trapped interstitials. Stage I_n-3, controlled by an activation energy of 0.59 ev, follows complex kinetics that can be considered a generalization of a second-order reaction. Although the interpretation of this stage is not conclusive, evidence supports the idea that a multiple vacancy-type defect (quadri-vacancy) annihilates by recombination with an immobile interstitial aggregate. (auth)

2335 THERMAL CONDUCTANCE OF GRAPHITE IN RELATION TO ITS DEFECT STRUCTURE. C. N. Hooker, A. R. Ubbelohde, and D. A. Young (Imperial Coll. of Science and Tech., London). Proc. Roy. Soc. (London), Ser. A., 276: 83-95(Nov. 5, 1963).

Apparatus developed for measuring thermal resistivities of well-oriented graphites in both a- and c-axis directions was used over a range of temperatures from 90 to 350°K. In graphites prepared by pyrolysis of methane, the proportion of defects was varied by changing the conditions of deposition, and by annealing up to 3000°C. Selected specimens were also irradiated with fast neutrons and were studied before and after annealing. To characterize the disorder in other ways, measurements of electrical resistivity and of thermoelectric power as a function of temperature were made in appropriate cases. Results are discussed with reference to mechanisms of thermal conductance in graphites. (auth)

2336 RESULTS OF RADIATION TEST ON MATERIALS AND COMPONENTS FOR NUCLEAR ROCKET APPLICATIONS. A. O. Burford (Lockheed Aircraft Corp., Marietta, Ga.). Trans. Am. Nucl. Soc., 6: 302-4(Nov. 1963).

2337 TRANSIENT RADIATION EFFECTS ON ELECTRON EMISSION OF HIGH-RESISTIVITY LAYERS. I. Cantarell and J. A. Gonzalo (Puerto Rico Nuclear Center, Mayaguez). Trans. Am. Nucl. Soc., 6: 345(Nov. 1963).

2338 IDENTIFICATION OF THE MOLTEN ZONE IN IRRADIATED UO_2. Glen R. Horn and James A. Christensen (General Electric Co., Richland, Wash.). Trans. Am. Nucl. Soc., 6: 348(Nov. 1963).

2339 THE IRRADIATED PERFORMANCE OF ZrO_2/PuO_2 FUEL MATERIAL. M. D. Freshley and D. F. Carroll (General Electric Co., Richland, Wash.). Trans. Am. Nucl. Soc., 6: 348-9(Nov. 1963).

2340 IRRADIATION OF URANIUM–PLUTONIUM OXIDE. W. J. Bailey and T. D. Chikalla (General Electric Co., Richland, Wash.). Trans. Am. Nucl. Soc., 6: 350 (Nov. 1963).

2341 THE SWELLING OF $U^{235}O_2$ IN A MATRIX OF NATURAL URANIUM OXIDE IN A PLATE-TYPE FUEL ELEMENT. Harvey B. Meieran (Westinghouse Electric Corp., Pittsburgh). Trans. Am. Nucl. Soc., 6: 350-1 (Nov. 1963).

2342 CRACKING AND BULK MOVEMENT IN IRRADIATED URANIUM OXIDE FUEL ELEMENTS. A. S. Bain (Atomic Energy of Canada Ltd., Chalk River, Ont.). Trans. Am. Nucl. Soc., 6: 352-3(Nov. 1963).

2343 NEUTRON IRRADIATION AND COLD-WORK EFFECTS ON ZIRCALOY-2 CORROSION AND HYDROGEN PICKUP. W. A. Burns and H. P. Maffie (General Electric Corp., Richland, Wash.). Trans. Am. Nucl. Soc., 6: 371 (Nov. 1963).

2344 THE IRRADIATION BEHAVIOR OF URANIUM MONOSULFIDE. L. A. Neimark and P. D. Shalek (Argonne National Lab., Ill.). Trans. Am. Nucl. Soc., 6: 372(Nov. 1963).

2345 SWELLING OF CAST THORIUM/URANIUM ALLOYS DURING IRRADIATION AND POSTIRRADIATION ANNEALING. J. H. Kittel, C. F. Reinke, and J. A. Horak (Argonne National Lab., Ill.). Trans. Am. Nucl. Soc., 6: 372-3(Nov. 1963).

2346 HIGH-TEMPERATURE IRRADIATION TESTING OF URANIUM/ALUMINUM FUELS FOR THE ATR. W. C. Francis, V. A. Walker, and G. W. Gibson (Phillips Petroleum Co., Idaho Falls, Idaho). Trans. Am. Nucl. Soc., 6: 373(Nov. 1963).

2347 BEHAVIOR OF IRRADIATED METALLIC FUEL ELEMENTS EXPOSED TO NUCLEAR EXCURSIONS IN TREAT. J. H. Monaweck, C. E. Dickerman, and E. S. Sowa (Argonne National Lab., Ill.). Trans. Am. Nucl. Soc., 6: 374-5(Nov. 1963).

2348 IRRADIATION STUDIES OF CERAMIC-COATED NUCLEAR FUEL PARTICLES. Charles W. Townley, Neil E. Miller, Robert L. Ritzman, and Richard J. Burian (Battelle Memorial Inst., Columbus, Ohio). Trans. Am. Nucl. Soc., 6: 378(Nov. 1963).

2349 DEVELOPMENT OF FUELED GRAPHITE CONTAINING PYROLYTIC-CARBON-COATED CARBIDE PARTICLES FOR NON-PURGED, GAS-COOLED REACTOR SYSTEMS. W. O. Harms (Oak Ridge National Lab., Tenn.). Trans. Am. Nucl. Soc., 6: 378-9(Nov. 1963).

2350 INITIAL STUDY OF THE EFFECTS OF HIGH TEMPERATURE AND HIGH RADIATION FIELDS ON THE ELECTRICAL INSULATING PROPERTY OF ALUMINA. Gary Dau (Univ. of Arizona, Tempe) and Monte V. Davis. Trans. Am. Nucl. Soc., 6: 383(Nov. 1963).

2351 EFFECT OF IRRADIATION TEMPERATURE AND ANNEALING TEMPERATURE ON EXPANSIONS AND CONTRACTIONS IN ALTERNATELY IRRADIATED AND ANNEALED GRAPHITE. Donald G. Schweitzer and Robert M. Singer (Brookhaven National Lab., Upton, N. Y.). Trans. Am. Nucl. Soc., 6: 383-4(Nov. 1963).

2352 FISSION-FRAGMENT-INDUCED STRESSES IN CERAMIC MATERIALS. T. S. Elleman, R. B. Price, and D. N. Sunderman (Battelle Memorial Inst., Columbus, Ohio). Trans. Am. Nucl. Soc., 6: 384-5(Nov. 1963).

2353 NUCLEAR RADIATION EFFECTS ON POTENTIAL NUCLEAR SPACECRAFT THERMAL CONTROL MATERIALS. J. E. Gilligan (Lockheed Missile and Space Co., Palo Alto, Calif.). Trans. Am. Nucl. Soc., 6: 385-6(Nov. 1963).

2354 EFFECT OF RADIATION ON MECHANICAL PROPERTIES OF CVTR PRESSURE-TUBE MATERIAL. W. R. Smalley (Westinghouse Electric Corp., Pittsburgh). Trans. Am. Nucl. Soc., 6: 386-7(Nov. 1963).

2355 IN-REACTOR MONITORING OF THE ZIRCALOY-2 PRTR PRESSURE TUBES. D. R. Doman and P. J. Pankaskie (General Electric Co., Richland, Wash.). Trans. Am. Nucl. Soc., 6: 387-8(Nov. 1963).

2356 A STUDY OF THE STRUCTURAL CHANGES AND CORROSION SUSCEPTIBILITY OF IRRADIATED 304 STAINLESS STEEL. W. S. Hazelton, C. J. Kubit, and D. R. McClintock (Westinghouse Electric Corp., Pittsburgh). Trans. Am. Nucl. Soc., 6: 388(Nov. 1963).

2357 NEUTRON-SPECTRAL EFFECTS ON INTERPRETATION OF RADIATION-DAMAGE EXPOSURE. K. Shure (Westinghouse Electric Corp., Pittsburgh). Trans. Am. Nucl. Soc., 6: 388-9(Nov. 1963).

2358 DEGRADATION OF IMPACT ENERGY OF STEEL AS A FUNCTION OF NEUTRON EXPOSURE. A. D. Rossin (Argonne National Lab., Ill.). Trans. Am. Nucl. Soc., 6: 389-90(Nov. 1963).

2359 THE IRRADIATION PERFORMANCE OF MgO/PuO_2 FUEL MATERIAL. M. D. Freshley and D. F. Carroll (General Electric Co., Richland, Wash.). Trans. Am. Nucl. Soc., 6: 396-7(Nov. 1963).

2360 DESIGN OF A CAPSULE FOR HIGH-TEMPERATURE FUEL IRRADIATION. C. W. Savery and Dale E. Johnson (General Atomic Div., General Dynamics Corp., San Diego, Calif.). Trans. Am. Nucl. Soc., 6: 404(Nov. 1963).

2361 MEASUREMENT AND CALCULATION OF THE ENERGY DEPOSITION AND THE FAST-NEUTRON FLUX INSIDE ANNULAR URANIUM FUEL ELEMENTS. A. W. Boyd, S. A. Kushneriuk, and J. J. Pieroni (Atomic Energy of Canada Ltd., Chalk River, Ont.). Trans. Am. Nucl. Soc., 6: 404-5(Nov. 1963).

2362 POST-IRRADIATION EXAMINATION OF RODS FOR MONITORING FISSION-GAS PRESSURE. Myron B. Reynolds (General Electric Co., Pleasanton, Calif.). Trans. Am. Nucl. Soc., 6: 405-6(Nov. 1963).

2363 CONTROLLED-FLUX IRRADIATIONS FOR MEASUREMENTS ON HIGH-PERFORMANCE FUELS. D. P. Hines, J. O. Arterburn, G. L. O'Neill, and E. L. Zebroski (General Electric Co., San Jose, Calif.). Trans. Am. Nucl. Soc., 6: 406-7(Nov. 1963).

2364 ON THE COMBINED EFFECTS OF IRRADIATION AND SURFACE-ACTIVE MEDIA ON MECHANICAL PROPERTIES OF METAL MONOCRYSTALS. V. I. Likhtman and O. A. Troitskii. Zh. Fiz. Khim., 37: 1893-5 (Aug. 1963). (In Russian)

A prolonged exposure of zinc monocrystals to P^{32} β irra-

diation resulted in reduced yield strength while a short term exposure (10 to 25 hrs) improved the yield strength property of the metal. (R.V.J.)

2365 RADIATION DAMAGE IN REACTOR MATERIALS. Proceedings of the Symposium on Radiation Damage in Solids and Reactor Materials Held in Venice, 7-11 May 1962. (International Atomic Energy Agency, Vienna). Proceedings Series. Aug. 1963. 774p. (STI/PUB/56a). $15.00; Sch 315,-; 90.stg; F.fr.60.-; DM 52.50 (IAEA)

Thirty papers and 3 reviews of papers and panel discussions presented at the Symposium on Radiation Damage in Solids and Reactor Materials are given. Eighteen papers were previously abstracted for NSA. Separate abstracts were prepared for the remaining 15 papers. (M.C.G.)

For abstracts of individual papers see: 2366, 2367, 2368, 2369, 2370, 2371, 2372, 2373, 2374, 2375, 2376, 2377, 2378, 2379, and 2380.

2366 RADIATION DAMAGE IN FISSIONABLE MATERIALS: REVIEW OF PAPERS AND PANEL DISCUSSION. p.3-12 of "Radiation Damage in Reactor Materials." Vienna, International Atomic Energy Agency, 1963.

The mechanisms of radiation damage in fissionable materials are discussed. Topics covered include: self-irradiation of plutonium and its delta alloys, cracking of irradiated uranium, diffusion and precipitation of rare gases in metals, swelling of uranium, dimensional stability of uranium under irradiation, radiation stability of U-10 wt % Mo alloy, annealing kinetics of alpha-uranium, and internal friction in uranium. (M.C.G.)

2367 DIMENSIONAL STABILITY OF URANIUM UNDER IRRADIATION. J. H. Gittus, V. W. Eldred, A. Stuttard, G. Slattery, and F. Chatterley (United Kingdom Atomic Energy Authority, Springfields, Lancs and Windscale, Cumb, Eng.). p.109-32 of "Radiation Damage in Reactor Materials." Vienna, International Atomic Energy Agency, 1963.

The practical importance of irradiation-induced dimensional changes is outlined, and the several mechanisms leading to dimensional instability are summarized. Changes in volume occur, attributable to the accumulation of solid and gaseous fission products and to phase changes. Changes in shape, such as the accentuation of bow in vertically stacked uranium fuel rods, are ascribed mainly to radioinduced creep. Theories seeking to explain the phenomenon are reviewed, as are the laws which appear to govern irradiation creep, isothermal creep, and thermal-cycling creep. Changes in length, partly due to the presence of preferred orientation in the fuel rod were observed and compared with physical measurements of the type of orientation present. These measurements are cataloged for a variety of uranium fuels. Methods of producing fuel of controlled texture are postulated and tested. (auth)

2368 THE EFFECT OF IRRADIATION TEMPERATURE AND FISSION RATE ON THE RADIATION STABILITY OF THE URANIUM-10 WT % MOLYBDENUM ALLOY. A. A. Shoudy, W. E. McHugh, and M. A. Silliman (Atomic Power Development Associates, Inc., Detroit). p.133-62 of "Radiation Damage in Reactor Materials." Vienna, International Atomic Energy Agency, 1963.

The radiation stability of uranium-10 wt % molybdenum alloy was studied. This radiation program, carried out as a part of the research and design effort for the Enrico Fermi Atomic Power Plant, covered the evaluation of various radiation parameters such as fission rate, fuel temperature, and burnup. Of the parameters studied, fission rate was found to have the most pronounced effect on the dimensional stability of the fuel alloy, particularly in the temperature range of 480 to 570°C. For material irradiated at a fission rate greater than 8×10^{13} fissions/cm^{3}s, diametral increases of about 3% were observed for burnups up to 7.5×10^{20} fissions/cm^3 at temperatures less than 630°C. At fission rates less than 6×10^{13} fissions/cm^{3}s and radiation temperatures of 480 to 570°C, the diameter changes became increasingly larger for decreasing fission rates. Post-irradiation examination showed that the loss of dimensional stability can be directly related to the transformation kinetics of the fuel alloy while under irradiation. At high fission rates, the metastable gamma phase continued to exist and the diameter changes were small and relatively insensitive to burnup. At progressively lower fission rates, the alloy transformed partially or completely to the equilibrium alpha plus delta (or gamma) phases, the degree of transformation depending on the absolute fission rate and the radiation temperature. Under these conditions, diameter increases for burnups of about 5×10^{20} fissions/cm^3 ranged from 3 to 14% for fission rates of 5×10^{13} to 2×10^{13} fissions/cm^{3}s respectively, and were highly dependent on burnup. Data relating dimensional stability to burnup, radiation temperature, and fission rate for zirconium-clad uranium-10 wt % molybdenum fuel pins are presented. These specimens were fabricated according to the fuel specifications for the Enrico Fermi Reactor. (auth)

2369 SOME EFFECTS OF IRRADIATION ON THE FUEL TYPES UNDER CONSIDERATION FOR THE "RAPSODIE" REACTOR. J.-P. Mustelier (Centre d'Études Nucléaires, Saclay, France). p.163-83 of "Radiation Damage in Reactor Materials." Vienna, International Atomic Energy Agency, 1963. (In French)

Two types of fuel are being considered for use in the core of the "Rapsodie" reactor: the U-Pu-Mo alloy, containing 20% plutonium and 10% molybdenum, and the mixed oxide UO_2-PuO_2, containing 25% PuO_2. Twenty-four samples of as-cast U-Pu-Mo alloy were irradiated in the EL3 reactor at burnups between 4400 and 8300 MWd/t. The unclad samples were immersed in liquid sodium at various temperatures from 400 to 525°C. Examination of the samples following irradiation showed that they had increased in volume by between 30 and 104%. The bubbles causing this swelling can be seen in micrographs. Six fuel elements in the form of needles, four consisting of enriched uranium oxide and two of the mixed oxide UO_2-PuO_2, were irradiated in the EL3 reactor. The temperature of the cladding was 450°C and the specific power was between 1000 and 1750 W/cm^3. Examination of the needles provided some data on their behavior under irradiation. (auth)

2370 RADIATION DAMAGE IN CERAMIC NUCLEAR FUEL. [REVIEW OF PAPERS AND PANEL DISCUSSION]. p.187-216 of "Radiation Damage in Reactor Materials." Vienna, International Atomic Energy Agency, 1963.

Topics covered in the discussion of radiation damage in ceramic nuclear fuels include: radiation effects in fissile oxides and carbides at low and high burnup levels, low-temperature irradiation behavior of cast uranium carbide, effect of irradiation on uranium-carbon systems with composition near that of UC, irradiation behavior of uranium carbide, effects of high burnup on oxide ceramic fuels, irradiation alteration of uranium dioxide, irradiation of fuels envisaged for the Rapsodie reactor, and irradiation experiments with fuel suspensions. (M.C.G.)

2371 EFFECT OF IRRADIATION IN EL.3 ON URANIUM-CARBON ALLOYS OF COMPOSITION CLOSE

TO THAT OF UC AND PREPARED BY SINTERING REACTION UNDER LOAD. A. Accary, R. Darras, and R. Caillat (Centre d'Études Nucléaires, Saclay, France). p.275-86 of "Radiation Damage in Reactor Materials." Vienna, International Atomic Energy Agency, 1963. (In French)

An experimental annular rod (280 mm long, and 30 mm external and 20 mm internal diameter), composed of a uranium–carbon system (4.6% carbon by weight), prepared by sintering at 1000°C under load and subjected to stabilization heat-treatment at 1200°C, was irradiated to a burnup of 700 MWd/t in the lattice of the EL.3 reactor. The maximum temperature of the test pieces was kept in the neighborhood of 620°C. In spite of abrupt variations in temperature, due to the changing operating conditions of the reactor, it was possible by following the changes in the fuel temperature to ascertain that the latter had undergone the treatment satisfactorily. Macrographic and micrographic examinations after irradiation confirmed and extended the observations made during irradiation. In addition, small test pieces, which were weakly irradiated at approximately ambient temperature, were heated to 1400°C in a vacuum and the rate of liberation of Xe^{133} was measured, giving a value for an apparent coefficient of diffusion. Samples prepared by sintering reaction under load and by fusion under electronic bombardment were compared. The latter appeared to retain the fission gases better than the former. (auth)

2372 RECENT PROGRESS IN THE STUDY OF RADIATION DAMAGE IN GRAPHITE. [REVIEW OF PAPERS AND PANEL DISCUSSION]. J. H. W. Simmons (Atomic Energy Research Establishment, Harwell, Berks, Eng.). p.475-96 of "Radiation Damage in Reactor Materials." Vienna, International Atomic Energy Agency, 1963.

The production of radiation damage in graphite by neutrons and heavy particles, the annealing behavior of graphite, and dimensional changes in graphite are discussed. (M.C.G.)

2373 A COMPARATIVE STUDY OF THE EFFECTS OF FAST NEUTRONS ON MONOCRYSTALLINE AND ON NUCLEAR GRAPHITE. J. Blons, G. Perriot, and G. Tourand (Centre d'Études Nucléaires, Saclay, France). p.499-507 of "Radiation Damage in Reactor Materials." Vienna, International Atomic Energy Agency, 1963. (In French)

Samples of nuclear graphite and natural monocrystalline graphite were irradiated in the same position in a reactor and the changes in resistivity measured. By studying the elimination of this change in resistivity, the contribution of the non-graphited part to the changes in the physical properties of nuclear graphite as observed in reactors was determined. (auth)

2374 NEUTRON IRRADIATIONS OF POLYCRYSTALLINE GRAPHITE AT 78°K. L. Bochirol, E. Bonjour, and L. Weil (Centre d'Études Nucléaires, Grenoble, France). p.509-21 of "Radiation Damage in Reactor Materials." Vienna, International Atomic Energy Agency, 1963. (In French)

Crystalline graphite from various sources was irradiated at the set temperature of 78°K in the MELUSINE reactor at the Grenoble Nuclear Research Center. Preliminary results are given. (M.C.G.)

2375 PARAMETER MEASUREMENTS ON INDUSTRIAL GRAPHITE IRRADIATED IN LIQUID NITROGEN. M. Pluchery (Centre d'Études Nucléaires, Grenoble, France). p.523-9 of "Radiation Damage in Reactor Materials." Vienna, International Atomic Energy Agency, 1963. (In French)

Samples of graphite taken from rods intended for the G2 and G3 reactors at Marcoule were irradiated in a liquid-nitrogen loop. The doses given ranged from 0.15 to 1×10^{19} n/cm^2. These fluxes consisted of fast neutrons of energy greater than 1 Mev as measured on the sample. The temperature during irradiation did not exceed 78°K. An x-ray diffraction chamber was developed for measuring parameters at the temperature of liquid nitrogen without intermediate reheating. This chamber made it possible to obtain an accuracy of 0.001 Å for parameter a and 0.005 Å for c. The variation in parameter c as a function of the dose is linear in the range indicated, the increase in $\Delta c/c$ being equal to 0.03 at 10^{19} n/cm^2. The recovery of the parameter during annealing between 90°K and ambient temperature was briefly studied and compared with the measurements of liberated energy. (auth)

2376 AN EFFECT OF FLUX LEVEL AND FLUX SPECTRUM ON THE ACCUMULATION OF DAMAGE IN REACTOR-IRRADIATED GRAPHITE. H. Bridge (United Kingdom Atomic Energy Authority, Culcheth, Warrington, Lancs, Eng.), B. S. Gray, B. T. Kelly, and H. Soerensen. p.531-51 of "Radiation Damage in Reactor Materials." Vienna, International Atomic Energy Agency, 1963.

The results of an experiment to measure the effect of flux level on the damage accumulated in reactor-quality graphite when it is irradiated to fast neutron doses of 4×10^{19} n/cm^2 are presented. An effect is clearly demonstrated from measurements of electrical and thermal resistivity, Young's modulus, and dimensional changes, which can be interpreted in terms of a dominant process in the damaging mechanism with an activation energy for thermal annealing of 1.2 ev. In addition, data are given comparing the changes in electrical resistivity occurring at low doses in an irradiation facility in a graphite-moderated reactor with those in a hollow fuel element facility in a heavy-water-moderated reactor. The variation with dose is shown to be of the same form in both cases, and is used to derive a relationship between the damaging powers of the neutron spectra in these facilities. The irradiation temperatures used during the main experiment were in the range 150 to 225°C, while the flux levels chosen are typical of the rigs used for accelerated materials-testing programs and of the core in current designs of graphite-moderated reactors. Thus, after consideration of the possible change in the effect with dose, the results of the two experiments are directly applicable to the problem of correcting the results of the accelerated tests in power reactor conditions. The use of an equivalent-temperature concept for this purpose is discussed. (auth)

2377 THE BEHAVIOR OF VARIOUS GRAPHITES UNDER NEUTRON IRRADIATION. E. Fitzer and O. Vohler (Siemens-Planiawerke A. G., für Kohlefabrikate, Meitingen, Ger.). p.593-650 of "Radiation Damage in Reactor Materials." Vienna, International Atomic Energy Agency, 1963.

The behavior of a wide range of reactor-grade graphites under controlled irradiation conditions was studied. Radiation damage as a function of different types of artificial graphite is considered. The graphite types differed only by their degree of crystalline order, even though they were produced under the same graphitizing conditions. The differences are caused by the different graphitizabilities of the raw materials. The dependence of the radiation damage on the graphite type seems to be of fundamental importance for the development of reactor-grade graphites with respect to various applications. Within one group the physical properties are changed in different ways for different graphite types. The differences of the unirradiated sam-

ples remain largely unchanged or are even more pronounced after irradiation. Mechanical properties, such as strength, Young's Modulus, and thermal expansion, fall into this group. The Wigner growth of various graphites under irradiation was studied systematically. Such properties are reported that are leveled out to a final value under the same irradiation conditions even when the raw materials are different. This is true for the thermal and electrical conductivity, the magnetic susceptibility, and to some extent for the lattice dimensions of the graphites. The effect of irradiation on the pore distribution of the various graphites is discussed. A correlation between Wigner growth and the shape of the sample is discussed. The results presented are compared with those reported in the literature, and it is shown that the absolute value of the Wigner growth depends on the shape of the irradiated graphite sample in such a manner that the specimens with the greatest length-to-width ratio show the greatest relative change in length after irradiation. Results of irradiations of the same graphite types in three different reactors, FRM, El.3, and GETR, are compared. The reactors differ in the neutron spectrum of their irradiation channels, and on the basis of the measured radiation damages the neutron doses can be estimated. It was found that in a test hole in the FRM the same irradiation damage is caused by a dose of 1×10^{19} n/cm^2 as in the core of the GETR at 1×10^{21} n/cm^2. In the EL.3, the equivalent degree of damage could not be achieved because of the low neutron energy at the irradiation channel. (auth)

2378 CHANGES IN THE PHYSICAL PROPERTIES OF GRAPHITE DUE TO REPEATED IRRADIATION AND ANNEALING. J. Rappeneau, A. Filiatre, G. Micaud, and M. Quetier (Centre d'Études Nucléaires, Saclay, France). p.663-83 of "Radiation Damage in Reactor Materials." Vienna, International Atomic Energy Agency, 196[illegible] French)

Under the effect of neutron irradiation at fairly low temperatures (40 to 150°C) graphite stores energy and the initial physical properties, such as thermal conductivity, crystal parameters, etc., are quickly altered. The graphite moderator of reactors operating at these temperatures must therefore be annealed fairly frequently. This is the case with the G-1 reactor at Marcoule, which has undergone three annealing operations, in 1958, 1959, and 1961. Measuring methods were developed for observing trends in the increase in internal energy or in the changes in thermal conductivity and crystal parameters. It is shown that with irradiated graphite the amount of energy liberated and the change $\Delta c/c$ in the parameter c increase linearly with dose at a given irradiation temperature. These relationships were established for graphite which had never undergone previous annealing and for relatively weak radiation doses (of the order of 10^{20} n/cm^2). The annealing operations performed on the moderator of the G-1 reactor leave a rather low residual energy in the graphite, at least at temperatures below 400°C, but the radiation damage to the graphite does not by any means completely disappear; the recovery of the crystal parameters is therefore relatively slight. Re-irradiation of the annealed graphite gives rise to effects which differ from those observed in graphite never previously annealed. Thus, before the second, third, and fourth annealings of the G-1 reactor moderator, an "early effect" was observed: the energy accumulated very rapidly at the beginning of re-irradiation, irrespective of the irradiation temperature. This "early effect" disappeared with fairly low irradiation doses (approximately 0.3×10^{20} n/cm^2), and then the energy, at a given irradiation temperature, again increased linearly with dose, the rate of increase being approximately that observed before the first annealing of the moderator. A study of the changes in thermal conductivity and crystal parameters seemed to indicate that there is an "early effect" similar to that observed for the internal energy. (auth)

2379 THE EFFECT OF HEAVY-PARTICLE BOMBARDMENT ON WIGNER-ENERGY STORAGE IN GRAPHITE. A. Willis and R. Penninckx (Centre d'Étude de l'Énergie Nucléaire, Mol, Belgium). p.685-9 of "Radiation Damage in Reactor Materials." Vienna, International Atomic Energy Agency, 1963.

The rate of Wigner energy storage can be accelerated, relative to neutron-bombarded graphite, if this material is bombarded by suitable quantities of heavy particles. This was shown by irradiation of porous graphite samples that were solution impregnated with uranium and boron. The particle size in these samples was so small that the heterogeneous mixture was homogeneously damaged. The uranium and boron reaction products had large differences in mass, initial charge, and reaction energy, and they gave rise to different rates of energy storage. The energy storage was nearly proportional to the total kinetic energy dissipated in the graphite. These data are interpreted. (auth)

2380 RADIATION EFFECTS IN SINTERED BeO BODIES OF SEVERAL COMPOSITIONS. C. G. Collins (General Electric Co., Cincinnati). p.725-45 of "Radiation Damage in Reactor Materials." Vienna, International Atomic Energy Agency, 1963.

Results are presented from a program to define radiation effects in BeO in terms of purity, density, grain size, porosity, and irradiation dosage and temperature. The initial data reported cover five BeO compositions prepared by extrusion and sintering of three commercially available grades of BeO of different purities and of one high-purity grade with MgO and ZrO_2 as additives. Specimens were of density 2.90 to 2.95 g/cm^3 and of 15 to 20 μm grain size, with the exception of one group of specimens of 50-μm grain size. Measurements were performed following irradiation at ~100°C to dosages up to $\sim 4 \times 10^{20}$ n/cm^2 ($\geq$1 Mev) and include lattice constants, dimensions, density, elastic constants, modulus of rupture, thermal expansion, thermal conductivity, and thermal annealing. Changes produced by irradiation were, in general, of the types and amounts observed previously but differed for the various compositions. Gross expansion of the specimens amounted to ~1% at the maximum dosage. Non-uniform growth in the diameter as compared to the length of the specimens of some compositions was attributed to grain orientation. Lattice expansion could be followed in powder-diffraction patterns up to a dosage of $\sim 1.9 \times 10^{20}$ n/cm^2; at higher dosages patterns were too diffuse for measurement. Young's modulus (dynamic) was increased about 1%. The modulus of rupture decreased to about 10% of the non-irradiated value and was more pronounced in the specimens of the less pure compositions. Thermal annealing measurements indicated that annealing was dependent on the amount of radioinduced expansion, i.e., on the dosage. In specimens irradiated to greater than $\sim 10^{20}$ n/cm^2, annealing of the gross expansion at temperatures up to 800°C was less than 20% in time periods up to 1000 hr. Essentially complete annealing occurred in ~40 hr at 1000°C and ~1 hr at 1100°C. Detailed annealing data and kinetics are discussed together with data on recovery of properties following annealing. (auth)

2381 TRANSIENT RADIATION EFFECTS IN CAPACITORS AND DIELECTRIC MATERIALS. H. W. Wick-

lein and R. H. Dickhaut (Boeing Co., Seattle). 16p. (CONF-299-1; D2-90173)

From IRE Western Electric Show and Convention, San Francisco, Aug. 1961.

Measurements of dielectric leakage, capacitance, electric strength, and charge scattering phenomena were performed at the Kukla and Godiva III critical assemblies for tantalum and aluminum electrolytic, wax- and oil-impregnated paper, mylar, mica, and ceramic capacitors, and for mylar and Vitamin Q-impregnated paper. Leakage data indicate that gamma induced conductivity in capacitor dielectric varies directly with $\dot{\gamma}\Delta$, where $\dot{\gamma}$ is the gamma radiation rate and Δ is 0.9 for mylar, 0.7 for Vitamin Q-impregnated paper, and approximately 1.0 for the other dielectrics. A small portion of the tantalum oxide conductivity induced by gamma radiation exhibited a recovery time of approximately 150 μs. Transient capacitance changes due to radiation were non-existent within ±0.1% for mica and Vitamin Q capacitors. Transient charging of tantalum capacitors was noted during irradiation with no applied voltage. No drastic changes in electric strength were noted during irradiation of mylar and Vitamin Q-impregnated paper. Results are compared with a summary of data previously collected by others. The use of test data in parametric form as a tool for predicting transient radiation effects is discussed. (auth)

2382 PULSED RADIATION EFFECTS ON THYRATRON TUBES. F. C. Tietze (International Business Machines Corp., Owego, N. Y.). 10p. (CONF-1-27).

From Institute of Electrical and Electronics Engineering 1963 Summer Meeting, Toronto, June 1963.

Thyratrons may be fired by intense pulses of nuclear radiation. The results of early experiments to characterize this phenomenon are re-evaluated in the light of recent results obtained in flash x irradiations. In particular, the recent experiments revealed a significant time delay between the radiation stimulus and the firing of the tube. The duration of the delay depends primarily on the plate voltage. The plate voltage also influences the grid bias necessary to prevent a tube from firing in a given radiation field. From these and other experimental evidences described, it was concluded that the tubes are fired by radioinduced ionization of the filling gas; previously the firing was generally attributed to radioinduced grid voltage transients. Data are presented to indicate that there is basic consistency of results obtained in pulsed reactor, linear accelerator, and flash x-ray environments. The appropriateness of the parameters used in the analysis of the early data is discussed and placed in question, although the data are taken to be valid. General guidelines for designing more pulse-radiation resistant thyratron circuits are given. (auth)

2383 EXPERIMENTAL TECHNIQUES OF PROTON ACCELERATOR BOMBARDMENT FOR SIMULATING PERMANENT SPACE RADIATION DAMAGE TO TRANSISTORS AND DIODES. R. R. Brown (Boeing Co., Seattle). 35p. (CONF-166-11).

From American Society for Testing Materials 66th Annual Meeting, Atlantic City, June 1963.

Sufficient information is known about the proton environment of space, basic radiation interactions, and concepts of shielding to allow laboratory simulation of permanent damage to transistors and diodes. A meaningful test simulates pertinent proton energy, intensity, and integrated flux. Contributing environmental factors such as temperature and vacuum must also be considered. Uniform exposures at low energies can be obtained by Rutherford scattering and charge of the direct beam can be collected by a Faraday cup. At high energies, defocusing or forward scattering can be used with foil activation for dosimetry. Transistor permanent damage threshold vary over a wide range and are a function of semiconductor material, effective base width, and construction type. For 10-Mev proton damage, inherent shielding also plays a vital role. Changes in inverse gain and inverse lifetime are observed to increase linearly with integrated proton flux. Operational lifetime under maximum Van Allen proton flux can vary from less than one month to many years, depending on transistor type. (auth)

2384 PROPOSED HIGH TEMPERATURE CAPSULE DESIGN FOR STEEL IRRADIATION. N. Omori and Y. Hirazawa (Mitsubishi Atomic Power Industries, Inc., Japan). 3p. (CONF-227-2)

From Problems in Irradiation–Capsule Experiment Conference, Germantown, Md., Oct. 1963.

The use of built-in single or multiple thin low melting point alloy layers for temperature control in high temperature irradiation capsules for steel or other materials is considered. The required properties of this alloy are outlined. A Pb–Sn alloy is suggested for the self temperature controlling system. (C.E.S.)

2385 OPEN TYPE CAPSULE FOR IRRADIATION OF SWAGED AND SINTERED UO_2 FUEL RODS. Y. Seki, T. Kubota, Y. Honda, and S. Takahashi (Mitsubishi Atomic Power Industries, Inc., Japan). 2p. (CONF-227-3)

From Problems in Irradiation–Capsule Experiments Conference, Germantown, Md., Oct. 1963.

Specifications of an open type capsule for the irradiation of swaged and sintered UO_2 fuel rods are presented. The Co wire method and Cs^{137} analysis method are used as neutron flux monitors. (C.E.S.)

2386 CAPSULES FOR IRRADIATION OF PRESSURE VESSEL STEEL SPECIMENS. Y. Seki, M. Mizuta, N. Omori, and Y. Hirazawa (Mitsubishi Atomic Power Industries, Inc., Japan). 3p. (CONF-227-4)

From Problems in Irradiation–Capsule Experiments Conference, Germantown, Md., Oct. 1963.

Specifications of high and low-temperature irradiation capsules for pressure vessel steel specimens are presented. The capsules use aluminum cladding. The low-temperature capsule is water cooled, and the high-temperature capsule has several layers of Pb–Sn or other Pb alloys to control the temperature of the test pieces. (C.E.S.)

2387 DOUBLE WALL TYPE CAPSULE WITH ENCLOSED NaK FOR IRRADIATION OF ENRICHED UO_2 FUEL RODS. Y. Honda, S. Takahashi, T. Kubota, and K. Ishikawa (Mitsubishi Atomic Power Industries, Inc., Japan). 2p. (CONF-227-5)

From Problems in Irradiation–Capsule Experiments Conference, Germantown, Md., Oct. 1963.

Specifications of a double-walled capsule for the irradiation of swaged and pelleted UO_2 fuel rods are presented. An enclosed Na–K liquid alloy serves as a heat transfer medium. The Co wire method and Cs^{137} analysis method are used as neutron flux monitors. (C.E.S.)

2388 CAPSULE FOR IRRADIATION OF PIN SPECIMENS OF STAINLESS STEEL SHEATHS REMOVED FROM SWAGED UO_2 FUEL RODS. S. Takahashi, Y. Honda, and

Y. Ikawa (Mitsubishi Atomic Power Industries, Inc., Japan). 2p. (CONF-227-1)

From Problems in Irradiation–Capsule Experiments Conference, Germantown, Md., Oct. 1963.

Specifications of an aluminum capsule for investigating neutron irradiation effects on stainless steel cladding material of swaged UO_2 fuel rods are presented. The capsule contains the cladding material in the form of pin specimens. (C.E.S.)

METEOROLOGY

Refer also to abstract 1575.

2389 (HW-77609(Sect.I)) ATMOSPHERIC PHYSICS. (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). 37p.

Atmospheric diffusion and transport studies emphasized both analysis of data collected in 1960 through 1962 and the continuation of field experiments over the Hanford Diffusion grids. Detailed analysis of tests performed at Hanford in 1960 and 1961 and tests performed with the same experimental technique at Cape Canaveral and Vandenberg Air Force Base in 1961 and 1962 demonstrated effects of climatic regimes and terrain on diffusion results. The experimental diffusion program at Hanford continued during the last half of 1962 with a series of ground releases designed to relate diffusion measurements out to 12.8 km to detailed wind structure, terrain, and length of release effects. Two additional ground releases were made over cheat grass fields, continuing the investigations begun in 1961 of the direct measurement of deposition on the surface. Another series of experiments provided the diffusion patterns at the surface, resulting from a continuous release at 185 ft. Dosage measurements were made on 9 arcs extending to a distance of 1600 m from the source. The data from the recent Hanford tests were reduced and preliminary analyses were made. (auth)

2390 (HW-SA-3220) COMPARISON OF RESULTS OF ATMOSPHERIC DIFFUSION EXPERIMENTS WITH CALCULATIONS FROM PREDICTION MODELS. James J. Fuquay and Charles L. Simpson (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Sept. 1963. Contract AT(45-1)-1350. 20p. (CONF-255-9)

From 8th Air Cleaning Seminar, Oak Ridge, Tenn., Oct. 1963.

Results of 340 diffusion experiments utilizing a ground source and encompassing a wide range of atmospheric stabilities are summarized. Peak exposures normalized for wind speed and source strength when plotted against the travel-time show stratification when stability and growth parameters are factored into the analysis. Differences in the results between sites are greatly reduced when diffusion is considered time-dependent, rather than being computed from the distance-from-source concept. In general, exposure limits for unstable, neutral, moderately stable, and stable meteorological conditions are established, and are compared with the predictions from some of the diffusion models. Whereas, the agreement between predicted and observed exposure values are good for diffusion in neutral and unstable atmospheres, there are significant differences noted in the stable case. Results of the Hanford model, which attempts to account for depletion of the plume through deposition, are presented. (auth)

2391 DISCUSSION OF PAPER BY W. F. LIBBY, "MORATORIUM FALLOUT AND STRATOSPHERIC STORAGE." Herbert W. Freely (Isotopes, Inc., Westwood, N. J.). J. Geophys. Res., 68: 6215-20(Nov. 15, 1963).

The paper "Moratorium Fallout and Stratospheric Storage" (NSA 17: 23527) is discussed with respect to the results of the uniform mixing model concerning Sr^{90} stratospheric storage time and fallout concentration during the nuclear moratorium. It is shown that the results are not in agreement with experimental observations. (C.E.S.)

2392 THE DEUTERIUM CONCENTRATION IN RAIN AND GROUND WATER. R. Brinkmann (Universität, Bonn), R. Eichler, D. Ehhalt, and K. O. Muennich. Naturwissenschaften, 50: 611-12(1963). (In German)

The question of how the deuterium concentration of ground water developed from the deuterium concentration of rain water was studied. The fluctuation of the deuterium concentration in the rain water, collected from January 1961 to September 1962, was shown and contrasted with the rather stable concentration in ground water. Possible reasons for the deuterium fractionation are briefly indicated. (J.S.R.)

2393 FISSION PRODUCT GAMMA ACTIVITY WITH NORTHERLY WINDS AND WITH SOUTHERLY WINDS. C. J. Brasefield (Illinois Univ., Carbondale). Science, 142: 952-3(Nov. 15, 1963).

The gamma ray activity of particulate matter filtered from air samples of northerly winds and of southerly winds was studied during the period October 1961 to May 1963 with a scintillation spectrometer. It was found that the gamma activity at 0.75, 0.49, and 0.145 Mev was greater when the wind was southerly than when the wind was northerly during the months December through May; the opposite was true from June through September. The gamma ray activity was least during the summer of 1962, the decrease being more pronounced for southerly winds than for northerly winds. The results can be accounted for by modifying the Brewer-Dobson theory of stratospheric circulation so that during most of the year stratospheric debris first reaches the ground south of latitude 40°N. No diurnal effect on the gamma ray activity of the samples could be detected. (auth)

PHYSICS

General

2394 (AD-422046(p.1-37)) TRANSIENT RESPONSE OF A FLUID-SOLID INTERFACE DUE TO AN IMPULSIVE PRESSURE-POINT SOURCE. Freeman Gilbert (California. Univ., La Jolla).

Analysis is made of the motion of a point in a semi-infinite solid resulting from an impulsive point source of pressure in a semi-infinite fluid elastic medium and at a distance z from the interface. An empirical method is given for relating the results of the problem of blast loading on air-earth interface. (auth)

2395 (AD-422046(p.86-91)) RADIOGRAPHIC OBSERVATION OF DYNAMIC SOIL PHENOMENA. F. H. Bloedow (General American Transportation Corp. MRD Div., Niles, Ill.).

A discussion is presented of two radiographic techniques which have been used to observe dynamic soil behavior. The first technique employs a constant potential x-ray machine and a moving film recording technique, and the second technique uses a flash x-ray source and image intensifier and camera recording system. (auth)

2396 (AD-422046(p.107-23)) EFFECTS OF VISCOSITY AND INELASTICITY UPON STRESS WAVES THROUGH CONFINED SOIL. Robert V. Whitman (Massachusetts Inst. of Tech., Cambridge).

An assessment is made of the probable influence of nonelastic effects upon the accuracy of prediction formulas and upon the question of stress attenuation with depth. It combines theoretical and experimental results to show that elastic ground motion prediction formulas are generally valid; i.e., the possible effects of viscosity and inelasticity are no greater than uncertainties as to the order of magnitude of the compressibility of an in situ soil mass. (auth)

2397 (AD-422046(p.124-40)) ENERGY DISTRIBUTION IN A HALF-SPACE UNDER NUCLEAR LOADS. G. L. Neidhart and J. B. Harkin (General American Transportation Corp. MRD Div., Niles, Ill.).

A solution is presented of the elastic half-space problem which will provide insight into the dominant features in which energy is propagated in rock or soil under blast loading. Response to a decelerating load and attenuation with depth due to geometric divergence of the rays of the seismic wave front are two effects revealed. (auth)

2398 (AD-422046(p.141-50)) MEASUREMENT OF ARRIVAL TIMES FOR AIR INDUCED COMPRESSIONAL AND SHEAR WAVES. Harry E. Auld (Air Force Special Weapons Center, Kirtland AFB, N. Mex.).

Experimental data from an omnidirectional peak stress time-of-arrival detector, designed for nuclear tests, are presented in support of a theory which suggests that waves propagating through the earth may, at certain stress levels, have a precursor wave form. Data obtained give clear evidence of an air-induced compression wave and detectable evidence of an air-induced shear wave. Wave velocities and pseudo elastic constants are presented. (auth)

2399 (AD-422046(p.188-93)) THE ATTENUATION OF SHOCKS IN CONSTRICTED CHANNELS. Hyman Serbin (Hughes Aircraft Co., Culver City, Calif.).

The propagation of shock waves in ducts of varying cross section was studied for the limiting cases of (1) weak shock wave and (2) slowly varying cross-section area. The case where a shock of finite strength impinges on an abrupt change in cross-section area is a complex phenomena requiring a nonlinear analysis. On the other hand, it is reasonable to expect that at large distances from the constriction, in those parts of the channel where the cross section is practically constant, the standard shock equations derived from steady flow will apply. If, in addition, one assumes that the flow is one-dimensional (so that the shocks are normal to the axis of the channel), then it is possible to derive flow patterns which are physically compatible with the environment imposed by an incident shock. The case of interest is where the channel opens into a reservoir which at some instant is suddenly brought to a high stagnation pressure and temperature. A shock wave moving down the channel develops. The flow in the channel is modified, however, by the presence of throats in the channel. The problem of particular interest is where there are two successive throats. In certain cases, a standing shock will form between the two throats. The presence of this shock implies a reduction in the stagnation pressure of the gas flowing along the channel. The principles described can be used to control shock strengths in channels. (auth)

2400 (INSJ-62) ON THE ANSWERS TO A QUESTIONNAIRE ON THE CONDITION OF RESEARCH IN THE FIELD OF LOW-ENERGY NUCLEAR PHYSICS. (Tokyo Univ. Inst. for Nuclear Study). 1963. 70p.

Data are summarized on low-energy nuclear research in 66 universities and other nuclear research organizations throughout the world. The data were compiled from answers to questionnaires received up to Aug. 1963. (C.H.)

2401 (IS-700(Sect.P)) PHYSICS DIVISION. (Ames Lab., Ames, Iowa). 70p.

Research progress in nuclear, high-energy, and solid-state physics is reported. Topics covered include: theoretical studies, synchrotron studies, nuclear spectroscopy, high-energy physics and accelerator design, metals and alloys, semiconductors, insulators, low-temperature and high-pressure studies, nuclear magnetic resonance, and solid-state theory and methods. (M.C.G.)

2402 (PAN-268) HYPERFINE STRUCTURE OF THE 14.4 kev GAMMA LINE OF ^{57}Fe IN SOME IRON OXY-HYDROXIDES INVESTIGATED WITH THE MOSSBAUER EFFECT. A. Z. Hrynkiewicz and D. S. Kulgawczuk (Polish Academy of Sciences. Inst. of Nuclear Physics, Krakow). May 1963. 10p.

The hyperfine structure of the 14.4-kev gamma line of Fe^{57} in lepidocrocite (γ-FeOOH) and geothite (α-FeOOH) was studied. In lepidocrocite only the quadrupole splitting $\Delta E = (0.45 \pm 0.05)$mm/sec is observed. In geothite, besides the quadrupole splitting $\Delta E = (0.24 \pm 0.05)$mm/sec, two values of the magnetic field intensity at iron nuclei $H_1 = (282 \pm 5)$ k oersted and $H_2 = (342 \pm 7)$k oersted are found. This indicates the existence of two sublattices in α-FeOOH. (auth)

2403 (PR-P-58) [PHYSICS]. Progress Report, April 1–June 30, 1963. (Atomic Energy of Canada Ltd. Chalk River Nuclear Labs., Chalk River, Ont.). 91p. (AECL-1831)

Studies are reported on fission, neutron reactions and spectra, ion beam production, nuclear reactions and decay schemes, nuclear-engineering instrument and technique

development, radiation detection, electronics development, and reactor instrumentation development. (T.F.H.)

2404 (TID-19651) QUARTERLY PROGRESS REPORT NO 71 [ON ELECTRONICS]. H. J. Zimmermann and G. G. Harvey (Massachusetts Inst. of Tech., Cambridge. Research Lab. of Electronics). Oct. 15, 1963. Contract AF33(616)-7624. 305p.

Research progress on meter protection circuitry, microwave electronics and spectroscopy, for infrared spectroscopy, nuclear magnetic resonance and hyperfine structure, radio astronomy, physical acoustics, plasma physics and electronics, magnetohydrodynamics, statistical communication theory, information processing and transmission, speech communication, linguistics, communications biophysics, neurology, neurophysiology, and noise in maser oscillators is reported. (D.C.W.)

2405 (TID-19665) SORPTION OF GASES ON METAL SURFACES IN ULTRAHIGH VACUUM. Quarterly Progress Report No. 5, May 15–August 15, 1963. R. A. Pasternak and Bjoern Bergsnov-Hansen (Stanford Research Inst., Menlo Park, Calif.). Sept. 16, 1963. Contract AT(04-3)-425. 7p.

The study of chemisorption and low-temperature sorption of nitrogen on molybdenum films was continued: the low-temperature sorption was found to be independent of porosity. In the mass spectrometer study of the hydrogen-deuterium exchange reaction, the effects of contaminant gases on the catalytic activity of hot filaments were studied. Thoria-coated tungsten filaments were developed for use as low-temperature electron emitters for ion gages and mass spectrometers. (D.L.C.)

2406 (UCRL-7322) CALCULATION OF ELASTIC-PLASTIC FLOW. Mark L. Wilkins (California. Univ., Livermore. Lawrence Radiation Lab.). Apr. 19, 1963. Contract W-7405-eng-48. 63p.

Equations of state in the elastic and plastic regions are developed that provide a theoretical description applicable to a wide class of practical problems but uses simple idealizations of the real phenomenon. The plastic state is described by continuously adjusting the stresses so that the yield strength is not exceeded. One- and two-dimensional elastic-plastic flows are considered. (D.L.C.)

2407 (WIS-TCI-32) AN EQUATION OF STATE OF GASES AT HIGH TEMPERATURES AND DENSITIES. J. S. Rowlinson (Wisconsin. Univ., Madison. Theoretical Chemistry Lab.). Aug. 15, 1963. 27p.

An equation of state is obtained in closed form for a gas composed of molecules with Lennard-Jones (n,½n) potentials. It is derived by summing over all the cluster integrals of the virial expansion that occur in the approximation for the pair distribution function proposed by Percus and Yevick. Each cluster integral is represented correctly to terms of the order of n^{-1}. The equation agrees well with machine calculations of the pressure of dense gases for $n = \infty$ and $n = 12$, with static measurements of the compression of gases at high reduced temperatures, and with some preliminary measurements of the density of argon compressed by shockwaves to pressures in the range 100-200 kb. (auth)

2408 (AERE-Trans-958) PHYSICAL PROPERTIES OF ROCK SALT TYPE LATTICES CONSISTING OF DEFORMED IONS. K. B. Tolpygo. Translated by M. Archer (U.K.A.E.A. Atomic Energy Research Establishment, Harwell, Berks, Eng.), from Zh. Eksperim. i Teor. Fiz., 20: 497-509(1950). 19p.

The interaction energy of neighboring ions, treated approximately on the basis of strong electron bonds, is determined as a function of their dipole moments and of their mutual distance. The equations of lattice vibrations are solved by taking into consideration the retardation of the interaction. In the case of long waves, the spectrum of the natural frequencies of the crystal lattice differs considerably from that yielded by Born's theory. The Born relation between the dielectric constant and the limit frequency of vibrations is also changed. The law of dispersion and the elastic constants of six alkali-halide crystals are determined, and the theoretically calculated and experimental data are compared. (auth)

2409 (FTD-TT-63-968) COSMIC RESEARCH. Translation of Kosmicheskie Issledovaniya, 1: No. 1, 1-192 (July-Aug. 1963). 347p.

Separate abstracts were prepared for eleven papers on extraterrestrial magnetic fields, radiation doses in space flight, space flight effects on plants, and the earth's magnetic and radiation fields. Seven other papers dealt with space vehicle orbits; atmospheric density, element distribution, and temperature; and meteoric matter in space. (D.C.W.)

For abstracts of individual papers see: 1326, 1327, 1962, 2036, 2513, 2556, 2557, 2724, 2725, 2726, and 2727.

2410 (UCRL-Trans-1003(L)) SHOCK WAVES IN A PLASTIC COMPACTING MEDIUM. A. S. Kompaneets. Translated by Sergey Shewchuck (Univ. of California Lawrence Radiation Lab., Livermore), from Dokl. Akad. Nauk. SSSR, 109: 49-52(1956). 6p.

The shock propagation of a plastic deformation in a medium which, at its initial state density ρ_0, has small resistance to compression, but when brought to density ρ_1 is incompressible and plastic is calculated. Relations for the maximum radius of wave expansion and the time of full expansion are obtained. (D.C.W.)

2411 DETERMINATION OF QUADRUPOLE COUPLING CONSTANTS OF THE TANTALUM-181 NUCLEUS IN THE $\underline{d}_{\frac{5}{2}}$ STATE IN SINGLE CRYSTAL FIELDS BY MEASUREMENT OF THE PERTURBED γ-γ ANGULAR CORRELATION AND THE CIRCULAR POLARIZATION. H.-J. Behrend (Deutsches Elektronen-Synchrotron, Hamburg-Grossflottbek, Ger.); D. Budnick, and K. Huber. Ann. Physik (7), 11: 372-93(1963). (In German)

The angular correlation of the 133 to 482 kev γ-γ cascade of Ta^{181} was modified by the interaction of the quadrupole moment with an electric field gradient during the life of the medium level ($\underline{d}_{\frac{5}{2}}$ state). The field gradient at the nuclear position was obtained by the introduction of radioactive Hf^{181} in the tetragonal lattice structure of a $HfOCl_2 \cdot 8H_2O$ single crystal and a prismatic hexagonal $(NH_4)_2HfF_6$ single crystal. From the measured dependence of the anisotropy of the correlation function on the spatial site of a preferred symmetry axis of the single crystal, the quadrupole coupling constants $B = Q(\underline{dE}/\underline{dz})$ for both cases could be determined. $B = -(1.1 \pm 0.3) \times 10^{-6}$ v in $HfOCl_2 \cdot 8H_2O$ and $|B| = (2.8 \pm 0.3) \times 10^{-6}$ v in $(NH_4)_2HfF_2$ were obtained. The sign of B was determined by measurement of the circular polarization of the 482-kev γ quanta. A simple model gives a negative sign for the electric field gradients so that a positive sign is obtained for the quadrupole moment of the $\underline{d}_{\frac{5}{2}}$ state. (tr-auth)

2412 ION ENERGIES PRODUCED BY LASER GIANT PULSE. William I. Linlor (Hughes Research Labs., Malibu, Calif.). Appl. Phys. Letters, 3: 210-11(Dec. 1, 1963).

Ion energies of ~1000 ev were produced by the action of

a single giant pulse from a ruby laser. The delivered energy was about 0.2 joules in a pulse having full width at half maximum of about 40 nsec. The peak power was 5.4 Mw. The area of the focal spot was approximately 10^{-3} cm^2. Energies were determined by the ion time-of-flight method. Foils of C, Al, Au, and Ti were target materials. (C.E.S.)

2413 PRODUCTION OF ULTRASOFT X RADIATION WITH POTENTIALS OF ABOUT 200 VOLTS. K. Mueller and B. Rajewsky (Max-Planck-Institut fur Biophysik, Frankfurt am Main). Biophysik, 1: 73-7(1963). (In German)

Beams with a total wave length of about 60 Å were produced in a windowless x-ray tube with the help of a suitable beam production system. Beam currents up to 15 mamp could be obtained. Microradiographic pictures with this radiation show that its intensity is maintained during the exposure time within acceptable limits. The experiments were continued in order to obtain data on the soft beam continuum and to determine the most favorable possibilities for a practical application. (tr-auth)

2414 ABSORPTION MEASUREMENTS ON X-RAY CONTRAST MEDIA WITH MONOCHROMATIC RADIATION. Guenter Schoknecht (Städt. Auguste-Viktoria-Krankenhauses, Berlin-Schöneberg). Biophysik, 1: 114-22(1963). (In German)

For the quantitative determination of the absorption properties of x-ray contrast media, experimental determinations of the mass absorption coefficients were made with crystal monochromatized x radiation of 0.711 Å. The apparatus and the measurement techniques are described. Investigations were made on water and on aqueous solutions of sodium iodide, biligrafin, and urografin. The experimental results are in agreement with the tabulated values of Koch and MacGillavry. The values calculated with the aid of the tabulated values are outside the limits of error. (tr-auth)

2415 THE THEORY OF KINETIC THRESHOLDS IN THE THERMODYNAMICS OF THE ISOLATED PARTICLE. Louis de Broglie. Compt. Rend., 257: 1822-4 (Sept. 16, 1963). (In French)

After a review of the manner in which the Hamiltonian principle of least action is connected to the entropy maximum in the de Broglie thermodynamics, it is shown how the question of kinetic thresholds is presented within this framework. (tr-auth)

2416 THE MOBILITIES OF NATURAL RADIOACTIVE IONS OBTAINED IN FILTERED AIR. Daniel Blanc, Jacques Fontan, and Manuel Juan (Faculté des Sciences, Toulouse). Compt. Rend., 257: 2099-2100(Oct. 7, 1963). (In French)

The mobilities of ions of ThA and ThB formed in the decay chamber of a device for the determination of the natural radioactive gases of the air are measured by the Zeleny method. The ions are divided into two mobility groups—0.82 ± 0.03 and 1.65 ± 0.05 $cm^2/sec/v$. (tr-auth)

2417 ELECTRON PARAMAGNETIC RESONANCE OF Gd^{3+} IN CaF_2, SrF_2, AND BaF_2. Jérôme Sierro (Université, Geneva). Helv. Phys. Acta, 36: 505-29(1963). (In French)

Electron paramagnetic resonance (EPR) measurements at room temperature were made on trivalent gadolinium ions in single crystals of CaF_2, SrF_2, and BaF_2 and also in natural fluorites. The effects of heat treatments and of hydrolysis at high temperature on the EPR spectra were studied. In CaF_2 there are four sets of spectra, the first having cubic symmetry, the second having axial symmetry about the cubic axes, and the two others having axial symmetry about the body diagonals of the cube. The spectra with cubic symmetry arise from Gd^{3+} ions substituted for Ca^{2+} ions without local charge compensation. The spectra with tetragonal symmetry are interpreted as resulting from Gd^{3+} ions that have a charge compensating F^- ion occupying the nearest neighbor interstitial site. The spectra with trigonal symmetry arise from Gd^{3+} ions that have an OH^- molecule ion or a charge compensating O^{2-} ion occupying the site of one of the eight F^- ions surrounding the paramagnetic ion. In SrF_2 the results are very similar, except that a trigonal spectrum is present in the samples as grown. In BaF_2, only the cubic and the trigonal spectra are observed. The later is interpreted as arising from Gd^{3+} ions substituted for divalent cations with a small displacement along one of the body diagonals of the cube. The deduced values of the parameters in the usual spin Hamiltonian are given for the different spectra. The minimum temperature at which hydrolysis takes place was determined to be about 500°C for CaF_2 and SrF_2 and about 600°C for BaF_2. In natural fluorites the spectra of Mn^{2+}, Eu^{2+}, and Gd^{3+} in cubic symmetry and also Gd^{3+} in tetragonal symmetry were observed. Furthermore, two spectra of color centers in relation with the natural color of some crystals were obtained. After x-ray irradiation some fluorites showed the spectra of the self-trapped hole center and that of atomic hydrogen. (auth)

2418 NUCLEAR MAGNETIC RESONANCE WITH STOCHASTIC HIGH-FREQUENCY FIELDS. R. R. Ernst and H. Primas (Swiss Federal Inst. of Tech., Zurich). Helv. Phys. Acta, 36: 583-600(1963).

The extension of double resonance methods in nuclear magnetic resonance is presented. The origin of the problem and its reduction to an abstract problem are discussed. The theorem that allows the calculation of the ensemble average of the linear response of a system with a strong time-dependent stochastic perturbation is given and applied to one-spin and two-spin systems with scalar coupling. The question of convergence is discussed and a relation between level shift and line broadening is stated. The nuclear magnetic resonance spectra are described in relation to the shape of the power spectrum of the stochastic perturbation. The example shows that the functional expansion of the density operator is useful to calculate the effects of strong stochastic perturbations on a quantum mechanical system. (M.C.G.)

2419 USING THE MÖSSBAUER EFFECT. V. I. Goldanskii. Intern. Sci. Technol., No. 24, 40-8(Dec. 1963).

The resonant emission and absorption of gamma rays are discussed in relation to the Mössbauer effect. Applications in chemistry are discussed, and one example given is confirmation of the polymer-like structure of SnF_4. Other applications implied include the use of the Doppler shift of the gamma ray as a sensitive noncontact motion-indicator and a technique of mineral assay. (R.E.U.)

2420 THE DYNAMICS OF SPACE-TIME. John A. Wheeler and Seymour Tilson. Intern. Sci. Technol., No. 24, 62-8; 70; 72-4(Dec. 1963).

The geometry of space, originally the slave of matter and only curving in response to the gravitational field created by matter, is shown to manifest curvature even in the absence of matter and this curvature must evolve through time. Curved empty space is a dynamic entity, as competent to store and carry energy as are ordinary elastic materials and electromagnetic waves. The consequences of quantization of general relativity are surveyed. (R.E.U.)

2421 THERMIONIC STUDIES OF VARIOUS URANIUM COMPOUNDS. George A. Haas and John T. Jensen, Jr.

(Naval Research Lab., Washington, D. C.). J. Appl. Phys., 34: 3451-7(Dec. 1963).

The thermionic constants of UO_2, UN, USi_2, UB_2, UB_4, UC, UC–ZrC, and evaporated films of U on W were determined using a pulsed strong-field Schottky method within the temperature range of 1200 to 2400°K. The results are consistent with the hypothesis that a film of uranium on the surface activates all of these compounds. This surface film can be provided by a natural excess of uranium in the compound, from a chemical reduction by the base metal, or by evaporation from an external source. The resulting active state for all of the compounds can be described within a factor of 2 or 3 by the empirical Richardson constants $\phi = 3.0$ ev, $A = 10$ A/cm^{2}deg^2. (auth)

2422 INVESTIGATION OF THE PATCH EFFECT IN URANIUM CARBIDE. George A. Haas and Richard E. Thomas (Naval Research Lab., Washington, D. C.). J. Appl. Phys., 34: 3457-65(Dec. 1963).

An electron beam scanning technique was devised to measure variations in the surface work function. These measurements indicate a wide patch distribution in the range of 3.25 to 4.5 ev for inactive uranium carbide, which upon thermal activation becomes covered with a surface having a work function in the narrow band of 3.0 to 3.25 ev. The active surface is very sensitive to ambient gases and can be easily poisoned to a value of work function higher than was the case for the inactive state. These results support the hypothesis that a uranium film is responsible for the activation as was suggested by previous thermionic measurements. An analysis of the effect of a nonuniformity in work function on thermionic measurements shows that experimental Richardson plots or effective work function plots can give highly erroneous results. The magnitude of this error can be determined and is expressed in terms of the spread of the patch distribution. (auth)

2423 ANALYSIS OF WAVE PROPAGATION IN A MAGNETOPLASMA-FILLED WAVEGUIDE. Joseph E. Willett (General Dynamics/Fort Worth, Tex.). J. Appl. Phys., 34: 3470-6(Dec. 1963).

A method is developed which permits a two-fluid analysis of wave propagation in a magnetoplasma-filled waveguide including the effects of Hall field, current inertia, space charge, unequal electron and ion temperatures, and diffusion. Maxwell's equations and the two-fluid equations expressed in one-fluid notation are reduced to a pair of coupled wave equations for the longitudinal components of the electromagnetic field. Approximate solutions are obtained for uncoupled TE and TM modes of propagation in a hydromagnetic waveguide. Included is a discussion of the effects of pressure, resistivity, displacement current, and current inertia on the dispersion relations. (auth)

2424 THERMAL VELOCITY EFFECTS IN AXIALLY SYMMETRIC SOLID BEAMS. P. T. Kirstein (CERN, Geneva). J. Appl. Phys., 34: 3479-90(Dec. 1963).

The effect of a Maxwelliam distribution of emission velocities on the longitudinal current density variation in axially symmetric solid beams is investigated to the paraxial approximation. The effects of both longitudinal and transverse initial emission velocities are included. The treatment permits variable magnetic fields and apertures which intercept some of the beam. Some particles may be turned back because all their energy is forced into the transverse motion; the reduction of the transmitted current density is evaluated. A simple illustrative example is given. (auth)

2425 SECONDARY ELECTRON PRODUCTION FROM ALPHA PARTICLES EMERGING FROM GOLD. James N. Anno (Battelle Memorial Inst., Columbus, Ohio). J. Appl. Phys., 34: 3495-9(Dec. 1963).

The secondary electron yield due to polonium-210 alpha particles emerging from a thin gold surface layer was determined to be 9.2 for an average alpha-particle charge of 1.86. This result is consistent with yield observations with other high energy charged particles. The ratio of the yield due to fission fragments at normal incidence coming from UO_2 coatings to the yield due to alpha particles at normal incidence coming from gold was found to be about 20, substantiating the assumption that the secondary yield is proportional to the mass stopping power of the target material. A weak dependency of the yield on electric field was observed; an increase of approximately 8% resulted from a field of 3×10^5 v/m. A slightly more pronounced field dependency was observed for the yield from fission fragments. (auth)

2426 FLUORESCENCE AND STIMULATED EMISSION FROM TRIVALENT EUROPIUM IN YTTRIUM OXIDE. N. C. Chang (General Telephone and Electronics Labs., Inc., Palo Alto, Calif.). J. Appl. Phys., 34: 3500-4(Dec. 1963).

Measurements are reported of the absorption, emission, and excitation spectra of Eu^{3+} in Y_2O_3, and also of fluorescence lifetime and quantum efficiency. An approximate level scheme is given. Conditions for laser action are calculated, and the results of a laser experiment are described. The importance of a strong ultraviolet excitation band probably corresponding to transitions from f-electron to d-electron levels is indicated. (auth)

2427 CHARGED PARTICLE ORBITS IN A LOGARITHMIC POTENTIAL. R. H. Hooverman (Univ. of Wisconsin, Madison). J. Appl. Phys., 34: 3505-8(Dec. 1963).

The equations of motion of a nonrelativistic particle in an attractive 1/r central force are developed and integrated by a digital computer. The results are presented graphically, and representative orbits are sketched. (auth)

2428 ELECTRON MICROSCOPE OBSERVATION OF FISSION FRAGMENT TRACKS IN PLASTICS. A. G. Malmon (National Institutes of Health, Bethesda, Md.). J. Appl. Phys., 34: 3634-5(Dec. 1963).

The effects of the passage of fission fragments through thin plastic films, as observed directly by transmission electron microscopy, are described. (R.E.U.)

2429 ON THE HAMILTONIAN REPRESENTATION OF A MULTI-VELOCITY STREAM. R. H. C. Newton (General Electric Co., Ltd., Wembley, Eng.). J. Electron. Control (1), 15: 301-18(Oct. 1963).

A nonrelativistic, collision-free hamiltonian development of the dynamics of a multi-velocity stream of charged particles moving in arbitrary electric and magnetic fields is given. The theory is presented using hydrodynamical variables, and is then applied to the case of a 1-dimensional, 1 degree-of-freedom electron beam, and the results are discussed in connection with noise suppression in 'O'-type beams. (auth)

2430 THE DYNAMICS OF DISCONTINUITY SURFACES IN GENERAL RELATIVITY THEORY. Dominic G. B. Edelen (Rand Corp., Santa Monica, Calif.) and T. Y. Thomas. J. Math. Anal. Appl., 7: 247-63(Oct. 1963).

A general dynamical theory of discontinuity surfaces and the associated jump strengths of both physical and geometrical quantities are presented. (auth)

2431 THE REMAINDER IN MAYER'S FUGACITY SERIES. Oliver Penrose (Yeshiva Univ., New York). J. Math. Phys. (N. Y.), 4: 1488-94(Dec. 1963).

Upper and lower bounds are obtained for the remainder after a finite number of terms of the expansions in powers of fugacity z for the pressure p, the s-particle distribution functions, the density ρ, and the fugacity coefficient z/ρ, for a system of particles with two-body interactions. The interaction potential must be either nonnegative or else have a hard core and decrease faster than r^{-3} at large distances. The results hold for all positive z, and apply to lattice gases as well as to fluids. For nonnegative potentials, the results imply that successive partial sums of each of these fugacity expansions provide alternate upper and lower bounds, valid even if the series diverges, on the physical quantity the expansion represents. (auth)

2432 INTEGRAL EQUATIONS AND INEQUALITIES IN THE THEORY OF FLUIDS. J. L. Lebowitz (Yeshiva Univ., New York) and J. K. Percus. J. Math. Phys. (N. Y.), 4: 1495-1506(Dec. 1963).

Using the method of functional Taylor expansion developed previously, an extensive set of equations is obtained for the distribution functions and Ursell functions in a classical fluid. These include in a systematic way many previously derived relations, e.g., Mayer–Montroll and Krikwood–Salsburg equations. By terminating the Taylor expansion after a finite number of terms and retaining the remainder, inequalities are also obtained for the distribution functions and thermodynamic parameters of the fluid. For the case of positive interparticle potentials, the inequalities first found by Lieb are recovered. For nonpositive potentials, new inequalities (some also obtained by Penrose) are derived. These inequalities are applied to the case of a hard-sphere fluid in three dimensions where they are compared with the results of machine computations and approximate theories. Different inequalities, not obtainable from the above considerations, and some properties of the fugacity expansions, are also derived. (auth)

2433 PERTURBATION APPROACH TO THE ELECTROSTATIC PROBLEM OF IRREGULARLY SHAPED CONDUCTORS. Victor A. Erma (Giannini Scientific Corp., Santa Ana, Calif.). J. Math. Phys. (N. Y.), 4: 1517-26 (Dec. 1963).

A simple and straightforward perturbation method for treating the electrostatic problem of a charged, irregularly shaped conductor is presented. The perturbation solution is generated starting from the zero-order solution for a charged sphere. The method consists of expanding the boundary condition in a Taylor series, which in effect transforms the boundary condition at the irregular boundary into a succession of boundary conditions to be satisfied at the surface of a sphere. The simplicity of the formalism consists further in applying, in a consistent manner, sufficient rather than necessary conditions on the successive correction potentials. First- and second-order expressions for the potential, surface charge density, and capacitance of irregularly shaped conductors, are derived explicitly, and an elementary theorem for the first-order capacitance is obtained. A perturbation expansion for the capacitance valid to all orders is presented. The application of the method is illustrated by calculating the capacitance of several irregularly shaped conductors. Possible generalizations to more complicated boundary-value problems are indicated. (auth)

2434 THEORY OF TRANSPORT COEFFICIENTS IN LOW-DENSITY GASES. James A. McLennan, Jr. (Lehigh Univ., Bethlehem, Penna.) and Robert J. Swenson. J. Math. Phys. (N. Y.), 4: 1527-36(Dec. 1963).

The evaluation of the correlation function expressions for transport coefficients is discussed. It is shown that for the case of a low-density nondegenerate monatomic gas with short-range interactions, results are obtained which are in agreement with those usually found from the Boltzmann equation. The analysis makes use of a generalized master equation, and of the factorization theorem of Kac. While the main concern is with low-density gases, the methods developed have a wider range of application. (auth)

2435 POINT DEFECTS IN LITHIUM FLUORIDE. Hubert Curien (Faculté des Sciences, Paris). J. Phys., 24: 543-51(July 1963). (In French)

A review of work on point defects in lithium fluoride is given. The electronic defects, vacancies, color centers, and larger defects are described. It is shown how these defects determine the electrical, optical, and mechanical properties of the lithium fluoride. The irradiation effects of x and γ rays and neutrons, at reactor temperatures or lower are also reported. (auth)

2436 PHOTOCONDUCTIVITY OF CsBr CRYSTALS CONTAINING COLOR CENTERS. Takehiko Ishii and Masayasu Ueta (Tohoku Univ., Sendai). J. Phys. Soc. Japan, 18: 1460-5(Oct. 1963).

The spectral distribution of photoconductivity was investigated at liquid He and N temperatures on additively colored and x-rayed CsBr. A peak was always found on the long wavelength side of the F band in the $\eta\omega$ spectral distribution curve. The absorption bands at 400 and 490 mμ at liquid N temperature appeared only when F centers were present. Photon absorption in these bands produced photocurrents, and the two bands were interpreted like the L bands in the NaCl-type alkali halides. At liquid He temperature, fine structure was resolved in the region below 600 mμ. A photoconductive band was developed on the long wavelength side of the F band by optical bleaching of the F band at liquid N temperature. (auth)

2437 PHOTO-MICROGRAPHIC OBSERVATIONS ON X-IRRADIATED ROCHELLE SALT CRYSTALS. Kenkichi Okada (Nagoya Inst. of Tech., Japan). Japan. J. Appl. Phys., 2: 613-20(Oct. 1963).

Observations on cavities in damaged rochelle salt and etch patterns on the surfaces are made photomicrographically. It is found that thin cavities are formed by thermal annealing after irradiation. Etch pits on c- and b-faces change from pyramidal to hip-roof-shaped while cavities are formed. Three types of cavities lie on three basic planes, each of which are arranged in layer structure. Hip-roof-shaped pits correspond to emergence lines of cavity planes on a crystal surface. Certain distributions of the cavities which presumably decorate dislocations were obtained. (auth)

2438 THE PRINCIPLE OF CONSERVATION OF MATTER AND MOTION AND THE LAW OF CORRELATION OF MASS AND ENERGY. V. Markov. Latvijas PSR Zinatnu Akad. Vestis, No. 6, 15-23(1963). (In Russian)

The law of mass and energy correlation expressed by $E = mc^2$ contains two main conservation laws: mass and energy. A philosophical analysis was made of $E = mc^2$ in relation to matter and motion conservation and of physical laws of conservation. (R.V.J.)

2439 ON THE THEORY OF THE MÖSSBAUER EFFECT. V. Kashcheev. Latvijas PSR Zinatnu Akad. Vestis, No. 8, 43-51(1963). (In Russian)

Calculations were made of the mean (per cell) thermal oscillation energy considering anharmonicity of the third order (in a second perturbation approximation) and of the fourth order (in first perturbation approximation). (R.V.J.)

2440 SOME POSSIBLE APPLICATIONS OF CIRCULAR HOMOGENEOUS MAGNETIC FIELDS $H_r = H_z = 0$, H_θ = CONST. H. Daniel (Max-Planck-Institut fur Kernphysik, Heidelberg). Nucl. Instr. Methods, 24: 181-4(Aug. 1963). (In German)

Possible applications of the circular homogeneous magnetic field $H_r = H_z = 0$, H_θ = constant are discussed: orange type β-ray spectrometer, orange type pair spectrometer, and magnetic bottle. The field can approximately be produced by a number of coils with constant current density along the radius, each coil being placed in a plane through the axis. In comparison with the existing 1/r-field orange type spectrometers, the proposed spectrometers with constant field should allow a higher maximum energy for a fixed size of the instrument and should be free of ghosts. With some limitations, the proposed magnetic bottle focuses all charged particles originating from the center back to the center, independently of the momenta. (auth)

2441 THE DESIGN OF A SIMPLE ELECTROMAGNET FOR MODERATE FIELDS. S. J. T. Owen and K. J. Standley (Univ. of Nottingham, Eng.). Nuovo Cimento (10), 26: Suppl. No. 2, 191-6(1962).

Experimental data are presented showing the improved performance of a simple electromagnet when its cylindrical poles are replaced by stepped poles. A field of 10,000 Oe in a 2½-in. gap is achieved for a power dissipation of 2½ kw. (auth)

2442 A GENERAL METHOD FOR CALCULATING THE TRANSFER MATRIX OF A MAGNETIC CHANNEL FOR CHARGED PARTICLES OBTAINED BY QUADRUPOLES AND ANALYZER MAGNETS. G. Sacerdoti and F. Uccelli (Università, Rome and Istituto Nazionale di Fisica Nucleare, Pisa, Italy). Nuovo Cimento (10), 26: Suppl. No. 2, 238-50(1962). (In Italian)

A process for evaluating the transfer matrix in magnetic channels for charged particles is exposed. The channel has to be obtained by quadrupole lenses and analyzer magnets. The elements of the transfer matrix can be expressed by a series expansion quickly converging. (auth)

2443 LAMINAR STEADY STATE ELECTROHYDRODYNAMIC FLOW IN AN ANNULAR CHANNEL. J. L. Shohet (Johns Hopkins Univ., Baltimore). Phys. Fluids, 6: 1759-61(Dec. 1963).

An analytic solution is obtained for the condition of laminar electrohydrodynamic flow in an annular channel. It is assumed the charged dielectric liquid has a constant density and mobility of charge, and the current density is constant across the channel. Velocity profile curves are presented. (auth)

2444 OBSERVATION OF A RESISTANCE MINIMUM IN CADMIUM BY MAGNETO-ACOUSTIC MEASUREMENTS. B. C. Deaton (General Dynamics, Fort Worth, Tex. and Univ. of Texas, Austin). Phys. Letters, 7: 7-8 (Oct. 15, 1963).

The free-electron theory of metals was used to find the ultrasonic frequency at which the high field limiting attenuation is equal to the zero field attenuation. Two 99.999% pure cadmium crystals in which the electron mean free path is thermal-phonon limited at 4.2°K were found to exhibit anomalous behavior of the temperature variation of the mean free path. The mean free path was found to be a maximum at 3°K. (R.E.U.)

2445 NOTE ON MØELLER'S GRAVITATIONAL STRESS-TENSOR. S. Deser (Universitetet, Copenhagen). Phys. Letters, 7: 42-3(Oct. 15, 1963).

Møeller's energy-momentum is compared to previous definitions that do not involve tetrads. A choice of gauge is made that makes the densities unique. The gauge conditions are local and depend implicitly on the coordinate frame in which the tetrad orientation is to be determined. (R.E.U.)

2446 de HAAS-SHUBNIKOV EFFECT IN ANTIMONY. J. Ketterson and Y. Eckstein (Argonne National Lab., Ill.). Phys. Rev., 132: 1885-91(Dec. 1, 1963).

The oscillatory components of the transverse magnetoresistance of single crystals of antimony were measured at 1.15°K in the range of magnetic fields from 4000 to 25,000 G using a derivative technique. Measurements were made for the field in the x–z, y–z, and x–y planes. Two sets of ellipsoidal carriers are clearly observed. One of the carriers was that observed by Shoenberg for which is found: $\alpha_{11}\alpha_{22} = 0.334 \times 10^{28}\ E_F^2$, $\alpha_{11}\alpha_{33} = 0.563 \times 10^{28}\ E_F^2$, and $\alpha_{11}\alpha_{23} = 0.352 \times 10^{28}\ E_F^2$. Also found for the second set of carriers is $\beta_{11}\beta_{22} = 0.0227 \times 10^{28}\ E_F^2$, $\beta_{11}\beta_{33} = 0.625 \times 10^{28}\ E_F^2$, $\beta_{11}\beta_{23} = 0.0424 \times 10^{28}\ E_F^2$, and $\beta_{22}\beta_{33} - \beta_{23}^2 = 0.0627 \times 10^{28}\ E_F^2$. Discussions are included relating this data to that of other experiments. (auth)

2447 NEW HOLE CENTER, FCl^-, IN MIXED KCl–KF CRYSTALS. John W. Wilkins and John R. Gabriel (Argonne National Lab., Ill.). Phys. Rev., 132: 1950-7(Dec. 1, 1963).

By x irradiation of a mixed KCl–KF crystal at liquid-nitrogen temperature, a molecule ion species identified as FCl^- can be formed oriented along a (111) axes of the crystal. The electron structure of this electron-deficient center was investigated by electron spin resonance. The parameters of the appropriate spin Hamiltonian were determined and are compared with those for F_2^- and Cl_2^-. A tentative assignment of signs for the isotropic parameter a is suggested. (auth)

2448 THERMAL CONDUCTIVITY OF SOME ALKALI HALIDES CONTAINING F CENTERS. Charles T. Walker (Cornell Univ., Ithaca, N. Y.). Phys. Rev., 132: 1963-75 (Dec. 1, 1963).

Thermal conductivity measurements are used to study phonon scattering by F centers in NaF, KCl, KBr, and KI. F centers were produced by additive coloration and by x and γ irradiation. The total effect on the thermal conductivity is seen to be different for the two methods of preparation. The additively colored data display two features: a low-temperature depression due to phonon scattering by colloids and quench-induced defects, and a high-temperature effect due to phonon scattering by F centers. The irradiated samples also display two features, a high-temperature effect due to F centers and a different low-temperature depression of unknown origin. The high-temperature data in irradiated samples can be explained if it is assumed that F centers are formed in regions of high concentration during irradiation. Several mechanisms are discussed for the low-temperature depression in irradiated crystals, including interstitials and the effect of dislocations on F-center formation. The F center is shown to produce quasilocalized impurity modes with frequencies of the order of 10^{13} sec^{-1}, and is seen to scatter phonons elastically primarily through its strain field. (auth)

2449 LIGHT SCATTERING IN ALKALI HALIDE SINGLE CRYSTALS. W. A. Sibley (Oak Ridge National Lab., Tenn.). Phys. Rev., 132: 2065-72(Dec. 1, 1963).

Light scattering by crystals of potassium chloride obtained from several commercial suppliers was measured.

All of the experimental observations can be explained by postulating that the scattering comes from dislocations which are surrounded by scattering centers having an anisotropic polarizability ellipsoid. The effective length of the scattering units is calculated from theory and experiment to be about 3×10^{-4} cm, and the effective radius is less than 2.5×10^{-6} cm. No correlation between the scattering power of a crystal and the growth rates of either the F band or M band under ionizing radiation was found. This suggests that the bad regions associated with the light scattering do not affect the coloration properties of a crystal. (auth)

2450 FAILURE OF THE ELECTRONIC QUASIPARTICLE PICTURE FOR NUCLEAR SPIN RELAXATION IN METALS. Leo P. Kadanoff (Univ. of Illinois, Urbana). Phys. Rev., 132: 2073-7(Dec. 1, 1963).

The range of validity of the quasiparticle picture is investigated by calculation of the temperature dependence of the nuclear spin relaxation time T_1. According to the simplest application of the quasiparticle picture, the electron-phonon interaction should produce a considerable deviation from the weak coupling law, T_1T = constant. This deviation is not observed experimentally. A more modern approach, based upon field theoretic techniques, predicts the constancy of T_1T and hence restores the agreement between theory and experiment. It is argued that the quasiparticle picture is a most inappropriate description of the effects of the electron-phonon interaction in metals. (auth)

2451 POLARIZATION OF He^3 GAS BY OPTICAL PUMPING. F. D. Colegrove, L. D. Schearer, and G. K. Walters (Texas Instruments Inc., Dallas). Phys. Rev., 132: 2561-72(Dec. 15, 1963).

The process of He^3 nuclear polarization by metastability exchange with optically pumped metastable He^3 atoms is described and experimental details given. Phenomenological theories are presented which explain the optical signals and the time variation of the polarization. The polarization is measured both optically and by nuclear magnetic resonance. Relaxation of the nuclear spins by diffusion through magnetic field gradients is discussed. When gradients are small, nuclear relaxation times as long as 4000 sec were measured. The maximum polarization achieved was 40 ± 5% in He^3 gas at a pressure of one mm Hg. (auth)

2452 CRYSTAL DYNAMICS OF GALLIUM ARSENIDE. J. L. T. Waugh and G. Dolling (Atomic Energy of Canada Ltd., Chalk River, Ont.). Phys. Rev., 132: 2410-12 (Dec. 15, 1963).

The dispersion relation for the normal modes of vibration propagating along the [ξ00], [ξξξ], and [0ξξ] directions in a single crystal of pure gallium arsenide at 296°K was determined by neutron spectrometry. The frequencies (units 10^{12} cps) of specific modes are (a) (0,0,0): TP 8.02 ± 0.08, LO 8.55 ± 0.20; (b) (1,0,0): TO 7.56 ± 0.08, TA 2.36 ± 0.015, LO 7.22 ± 0.15, LA 6.80 ± 0.06; (c) (0.5,0.5,0.5): TO 7.84 ± 0.12, TA 1.86 ± 0.02, LO 7.15 ± 0.07, LA 6.26 ± 0.10. The results are analyzed in terms of the dipole approximation model. Although a fairly complex version of this model provides a satisfactory description of most of the data, certain significant discrepancies remain. These indicate that the neglect of quadrupole interactions is a serious weakness of the dipole approximation model. (auth)

2453 EFFECTS OF ILLUMINATION ON THE THERMOLUMINESCENCE OF ALKALI HALIDES. A. A. Braner and M. Israeli (Hebrew Univ., Jerusalem). Phys. Rev., 132: 2501-5(Dec. 15, 1963).

Illumination with monochromatic light into the F- or V-absorption bands of KBr, KI, NaCl, and KCl single crystals at liquid nitrogen temperature (LNT), after x irradiation at room temperature (RT), reexcites different glow curves in the region between LNT and RT. F illumination produces a set of electron thermoluminescence peaks, and V light a set of hole peaks. Both sets of peaks add up to the regular glow curve obtained after x irradiation at LNT. The results are consistent with existing models of the thermoluminescence process. (auth)

2454 KNIGHT SHIFTS K_V, K_{Tc}, AND K_{Al}, AND MAGNETIC SUSCEPTIBILITIES IN THE bcc REGION OF THE V–Tc–Al TERNARY ALLOY SYSTEM. D. O. Van Ostenburg, D. J. Lam, H. D. Trapp, and D. W. Pracht (Argonne National Lab., Ill.). Phys. Rev. Letters, 11: 352-4(Oct. 15, 1963).

To investigate the concept of energy-band compatibility among transition and transition and nontransition elements, a study was made on the b-c-c region of the ternary V–Tc-Al alloy. The magnetic susceptibility is found to decrease with increasing Tc concentration and has a very small temperature dependence. Knight shifts for V^{51}, Tc^{99}, and Al^{27} are also determined. The magnitude of the Al shift is very small. Results indicate that the electrons contributing to the shifts of V and Tc enter a common band while the Al conduction electrons have little or no interaction with those of the transition elements. (C.E.S.)

2455 THEORY OF STRUCTURED CONTINUA. I. GENERAL CONSIDERATION OF ANGULAR MOMENTUM AND POLARIZATION. J. S. Dahler and L. E. Scriven (Univ. of Minnesota, Minneapolis). Proc. Roy. Soc. (London), Ser. A, 275: 504-27(Oct. 29, 1963).

Classical continuum theory is generalized to provide a systematic procedure for treating in successively greater detail the macroscopic manifestations of subcontinuum events without sacrificing the convenience of the field approach. The point of departure from traditional theory is the general angular momentum principle for continua. Internal angular momentum is associated with configurational and kinematic structure of the continuum particle and that structure is represented by moment expansions in polyadic polarization densities. Each step in the theoretical development is analyzed both in terms of the statistical mechanics of polyatomic media and from the standpoint of continuum physics. Accurate accounting of content and flux is found to require introducing the concepts of proper densities and currents. Among topics examined in detail are asymmetric states of stress, equations of change for dynamical variables, and equilibrium conditions in structured continua, including alinement of internal angular momentum with the principal axes of local mass distributions. (auth)

2456 CHARGING AND ACCELERATION OF MICROPARTICLES. James F. Vedder (Lockheed Missiles and Space Co., Palo Alto, Calif.). Rev. Sci. Instr., 34: 1175-83(Nov. 1963).

Development work on charging and acceleration of microparticles gives promise of a micrometeoroid simulator capable of producing velocities well into the meteoric range. Velocities up to 7 km/sec were attained with highly charged micron-size diamond particles with a 70-kv accelerating voltage. Single particles electrodynamically contained in a high vacuum are charged positively by an ion current to give charge-to-mass ratios approaching 400 C/kg. Once charged, the particle is extracted from the containing field and accelerated by a high potential. Preliminary work on charging microparticles of other materials demonstrates the possibility of producing high charge-to-mass ratios on many substances by this technique. (auth)

2457 NEUTRAL BEAM DETECTION. D. McKeown and A. Cabezas (General Dynamics/Astronautics, San Diego, Calif.). Rev. Sci. Instr., 34: 1261(Nov. 1963).

The rate of sputtering of a surface is used in neutral beam detection. Beam energies greater than 50 ev are required for measurable sputtering rates. (R.E.U.)

2458 AC FIELD EXCITATION OF RARE EARTHS IN ZINC SULFIDE. G. J. Goldsmith, S. Larach, R. E. Shrader, and P. N. Yocom (RCA Labs., Princeton, N. J.). Solid State Commun., 1: 25-7(June 1963).

The a-c field-excited luminescence of 4f-4f transitions of rare earths in zinc sulfide containing copper is reported. Details of the emission of Er^{3+} are presented, and tentative term assignments are derived. (auth)

2459 ON THE EFFECT OF ANHARMONIC VIBRATIONS OF THE LATTICE ON THE INTENSITY OF MÖSSBAUER'S LINE. I. A. Marushko (Dniepropetrovsk State Univ., USSR). Ukr. Fiz. Zh., 8: 836-43(Sept. 1963). (In Russian)

By means of field theory methods, the intensity of the Mössbauer line was calculated, taking into account anharmonism in lattice oscillations. The absence of local oscillation in the crystal is assumed. On expansion of the potential energy of the lattice atoms into a series, the terms of the third and fourth powers were taken into consideration in respect to displacement of atoms from the lattice points. For the case of temperatures higher than the Debye temperature the resulting corrections to the Mössbauer factor are proportional to the second and third powers with respect to the crystal temperature. (auth)

2460 ON VARIOUS METHODS OF CALCULATING DISPERSION IN A SPIRAL WAVEGUIDE WITH AN ANISOTROPIC MAGNETODIELECTRIC MEDIUM. B. V. Kondratev (Khar'kov State Univ.). Ukr. Fiz. Zh., 8: 844-54 (Sept. 1963). (In Russian)

The fields were determined in an axial anisotropic magnetodielectric medium. A dispersion equation was obtained for a spiral waveguide located on the boundary of two anisotropic magnetodielectrics with non-resonance corrections. Various types of refined boundary conditions are considered for the case of a spiral anisotropic magnetodielectric. Equivalent values of the dielectric and magnetic permeability are computed. Various methods for obtaining dispersion equations for the problem are compared. (auth)

2461 POLARIZATION ENERGY LOSSES OF A CHARGE MOVING ON A CIRCUMFERENCE IN A MEDIUM WITH DISPERSION. A. A. Vodyanitskii (Khar'kov Inst. of Physics and Tech.). Ukr. Fiz. Zh., 8: 855-860(Sept. 1963). (In Russian)

The polarization energy losses during the motion of a charge along a circumference of constant radius in an infinite dispersive medium with a dielectric permeability of $\epsilon(\omega) = \epsilon' + i\epsilon''$ are considered. The charge field is decomposed into harmonics that are multiples of the frequency of revolution of the charge on the circumference. An expression is obtained for the specific energy losses of the charge per unit of path. With small damping in the medium, intensive losses (of the order of $1/\epsilon''$) take place on the harmonic on which the real part of the dielectric permeability is close to zero. On harmonics where the real part of the dielectric permeability is considerably greater than the imaginary part, these losses are proportional to low damping in the medium, i.e., are small. Within a circumference of infinite radius the complete polarization losses, with damping tending toward zero, pass into the well-known expression for the energy losses of a charge moving rectilinearly and uniformly. (auth)

2462 LECTURES IN THEORETICAL PHYSICS. VOLUME V. LECTURES DELIVERED AT THE SUMMER INSTITUTE FOR THEORETICAL PHYSICS, UNIVERSITY OF COLORADO, BOULDER, 1962. Wesley E. Brittin, B. W. Downs, and Joanne Downs, eds. New York, Interscience Publishers, 1963. 591p. $12.00.

Lectures on behavior of De Broglie wave and wave packets, scattering matrix theory of particles and resonances, ferroelectricity in KH_2PO_4, quantum semiconductors, group theory in nuclear spectroscopy, dynamics of electrons in crystals, the Fermi surface of metals, the universe in the light of general relativity, and Mach's principle as boundary condition for Einstein's field equations were presented. Separate abstracts are prepared for 6 of the 9 lectures presented. (C.E.S.)

For abstracts of individual lectures see: 2521, 2683, 2718, 2719, 2720, and 2958.

2463 PARAMAGNETIC RESONANCE. VOLUMES I AND II. Proceedings of the First International Conference Held in Jerusalem, July 16-20, 1962. W. Low, ed. New York, Academic Press, 1963. 921p. $16.00.

Advances that have taken place since the discovery of ESR are summarized. Solids are the essential subject with the main sections devoted to ESR in the iron group and the rare earth groups, the theory related to these spectra, and the effects of electric fields, pressure, and temperature on these spectra. Recent results on ESR in semiconductors and biological matter and spin resonance of F centers, organic materials, and in glasses are presented. Of the 103 papers presented, 27 were chosen for NSA and one was previously included in NSA. (R.E.U.)

For abstracts of individual papers see: 1775, 2464, 2465, 2466, 2467, 2468, 2469, 2470, 2471, 2472, 2473, 2474, 2475, 2476, 2477, 2478, 2479, 2480, 2481, 2482, 2483, 2484, 2485, 2486, 2487, 2488, and 2489.

2464 PARAMAGNETIC RESONANCE AND OPTICAL ABSORPTION OF TRANSITION ELEMENT IONS IN $SrTiO_3$ AND $LaAlO_3$. K. A. Mueller (Battelle Memorial Inst., Geneva). p.17-43 of "Paramagnetic Resonance. Vol. I." New York, Academic Press, 1963.

The paramagnetic resonance and optical absorption of $SrTiO_3$ doped with chromium, manganese, and cobalt, as well as the PMR data on $LaAlO_3$ containing Gd^{3+} and Pr^{3+} are reviewed. The resonance data of the stable $3d^3$ Cr^{3+} and Mn^{4+} ions in $SrTiO_3$ are compared with the ones found in other oxide crystals. It is seen that with increasing covalent character, i.e., by going from Cr^{3+} to Mn^{4+}, the g-value and hyperfine constant become more independent of the particular oxide crystal in which the ion is incorporated. This proves to be true as well for the optical absorption transitions which were also obtained for Cr^{3+} and Mn^{4+} in TiO_2. The correlation of the PMR and optical data is briefly discussed in the light of the present theoretical knowledge. For Mn^{4+} the line width becomes broader and orientation-dependent compared to that of Cr^{3+} and is ascribed to the difference between the atomic radii of the Mn^{4+} and the Ti^{4+} it replaces in the lattice. The splitting of the PMR lines of Cr^{3+} in $SrTiO_3$ due to the tetragonal domains below the phase transition is discussed. It is pointed out that by observing the forbidden $\Delta(M + m) = 0$ transitions of an ion having a nuclear spin $I \geq \frac{1}{2}$ in a pure cubic field, one is able to verify analytically the electronic spin S even for a powdered sample, as in second order a constant term proportional to $S(S + 1)$ appears in the formula for the resonance magnetic fields. From paramagnetic resonance and optical absorption data on cobalt doped

$SrTiO_3$ as well as susceptibility measurements on cobalt doped $LaAlO_3$, it is concluded that the cobalt usually enters the lattice substitutionally at a Ti^{4+} or Al^{3+} site in the diamagnetic Co^{3+} $d\epsilon^6$ state. Deductions drawn from early resonance and roentgenographic data obtained on (Gd–La)AlO_3 ceramics prove to be correct in the light of recent resonance data of others with single crystals. These are: a) There is no phase transition between 300°K and 4.2°K. b) The main splitting of the $^6S_{\frac{5}{2}}$ state is due to the trigonal field. c) It is approximately proportional to $\Delta\beta$ where $\Delta\beta = 90° - \beta$, β being the rhombic angle of the perovskite unit cell compressed along the cube diagonal. $\Delta\beta$ increases on cooling. The small cubic field splitting parameter b_4^0 found in $Gd^{3+}:SrTiO_3$ is in good agreement with the present knowledge on the dielectric properties of the perovskite structure. The paramagnetic resonance of Pr^{3+} in $LaAlO_3$ at 4.2°K was analyzed giving $g_{||} = 2.67 \pm 0.02$, $g_\perp = 0$, $A = 0.119 \pm 0.03$ cm^{-1}, i.e., $(A/g_{||}) = 954 \pm 13$ gauss or 10% lower than found in the ethyl sulfate and double nitrate salts. This is ascribed to the higher A_2^0 coefficient in the electrical crystalline field of the trigonal $LaAlO_3$. (auth)

2465 ESR SPECTRA OF Cr^{3+} AND Gd^{3+} IN LANTHANUM ALUMINATE. D. Kiro, W. Low, and A. Zusman (Hebrew Univ., Jerusalem). p.44-50 of "Paramagnetic Resonance. Vol. I." New York, Academic Press, 1963.

The crystallographic structure of $LaAlO_3$ changes gradually with temperature. At temperatures below 435 ± 25°C, the $LaAlO_3$ undergoes a transition from a simple cubic cell to rhombohedral structure. The spectrum of Gd^{3+} and Cr^{3+} in single crystals of $LaAlO_3$ was measured as a function of temperature in the range of 700 to 4°K. The crystal field parameters change gradually and the total splitting decreases by a factor of two in this temperature range. (auth)

2466 ELECTRON PARAMAGNETIC RESONANCE OF SOME RARE EARTH IMPURITIES IN STRONTIUM TITANATE. L. Rimai and G. A. deMars (Raytheon Co., Waltham, Mass.). p.51-8 of "Paramagnetic Resonance. Vol. I." New York, Academic Press, 1963.

Data obtained from paramagnetic resonance of trivalent ytterbium and neodymium, and divalent europium in the crystal field of the $SrTiO_3$ lattice are presented. For Yb^{3+} and Nd^{3+} the resonance arises from the lowest lying Kramers doublet in the tetragonal field of the low temperature phase of the host crystal. The resonance of the $4f^7$ ^8S state of Eu^{2+} is observable also in the room temperature cubic phase. Comparison of the latter data with corresponding results on isoelectronic Gd^{3+} indicates a marked difference between the behavior of divalent and trivalent rare earth ions in this crystal. From these results it is concluded that the tetragonal distortion in the low temperature phase of $SrTiO_3$ must be exceedingly small and that the relatively large effects observed in trivalent rare earths are the result of an enhancement of this distortion by the interaction of these impurities with the host lattice. (auth)

2467 ON THE PARAMAGNETIC RESONANCE SPECTRA OF SOME RARE EARTH AND IRON GROUP IMPURITIES IN STRONTIUM TITANATE. R. S. Rubins and W. Low (Hebrew Univ., Jerusalem). p.59-67 of "Paramagnetic Resonance. Vol. I." New York, Academic Press, 1963.

The spectra of nickel, cerium, and neodymium were observed in single crystals of $SrTiO_3$. The nickel spectra may be classified as follows: (a) Broad($g = 2.21 \pm 0.01$) and narrow ($g = 2.204 \pm 0.001$) isotropic lines are attributed respectively to the normal and double quantum transitions of Ni^{2+} occupying a Ti^{4+} site. The narrow line is phase inverted at low microwave powers. (b) A narrow line ($g = 2.180 \pm 0.002$), isotropic at 200°K, is probably due to Ni^{3+} occupying a Ti^{4+} site. The observed g-value may be explained if the crystalline field is large enough to make ^2E the ground level. (c) Axial spectra, observed at 200°K, with principal g-values ($g_{||} = 2.030 \pm 0.001$, $g_\perp = 2.352 \pm 0.001$) similar to those for Cu^{2+} in a tetragonal field can possibly be attributed to Ni^{1+} occupying a Ti^{4+} site. Below 100°K $SrTiO_3$ becomes tetragonal and the unit cell possibly loses its center of symmetry. The effects of domain formation are observed as a splitting of the spectral lines. At 4.2°K axial spectra due to Ce^{3+} ($g_{||} = 3.005 \pm 0.005$, $g_\perp = 1.118 \pm 0.002$) and Nd^{3+} ($g_{||} = 2.609 \pm 0.003$, $g_\perp = 2.472 \pm 0.003$) were observed. (auth)

2468 PARAMAGNETIC RESONANCE OF IRON GROUP AND RARE EARTH IMPURITIES IN CALCIUM OXIDE. W. Low and R. S. Rubins (Hebrew Univ., Jerusalem). p.79-89 of "Paramagnetic Resonance. Vol. I." New York, Academic Press, 1963.

A systematic study of the magnetic properties of 3d and 4f transition ions in cubic crystalline fields is being carried out in single crystals of CaO. The results for the iron group indicate that the crystalline field in CaO is smaller than that in isomorphous MgO. Rare earth ions can also enter the larger CaO lattice, and the spectra of Eu^{2+} and Gd^{3+} were observed for the first time in surroundings of octahedral symmetry. The sign of the initial splitting parameter c for $4f^7$ in CaO is found to be the same as that recorded for eight-fold coordinated CaF_2. The magnitude of the initial splitting of the $^8S_{\frac{7}{2}}$ (f^7) level is smaller in CaO than in CaF_2, but the reverse appears to be true for $^6S_{\frac{5}{2}}(3d^5)$. Other striking results include large hyperfine splittings measured for Cr^{3+} and Co^{2+} in CaO, the latter being more than 30% greater than in MgO, an increase in the hfs of Mn^{2+} and V^{2+} as the temperature is decreased, and unusually short relaxation times in Cr^{3+}, Fe^{3+}, and Ni^{2+}—a result, probably of the weaker crystalline field strength in CaO. (auth)

2469 ELECTRON SPIN RESONANCE STUDIES OF IMPURITIES IN II-VI COMPOUNDS. P. Auzins, J. W. Orton, and J. E. Wertz (Univ. of Minnesota, Minneapolis and Mullard Labs., Salfords, Surrey, Eng.). p.90-104 of "Paramagnetic Resonance. Vol. I." New York, Academic Press, 1963.

Magnesium oxide serves as a nearly ideal host for electron spin resonance observations of transition metal ions. Other oxides, sulfides, and selenides of the alkaline earth metals were also used as hosts. For most ions, it is readily possible to change the valence state by irradiation or other treatment. The impurity which is usually present in MgO without doping is iron, which may be observed in single crystals in its mono-, di-, and trivalent forms. Other ions which were observed are those of vanadium, chromium, manganese, cobalt, nickel, copper, ruthenium, rhodium, palladium, and gadolinium. Hosts other than MgO were in the form of powders, and hence our observations were limited to isotropic spectra or those having a very small zero-field splitting. Strontium sulfide is outstanding for the number of spectra seen, giving sharper lines than any of the other powdered hosts. As the radius of the host cation increases relative to that of a substitutional cation, one comes to a host in which the spectrum of this impurity ion is not observed. However, the ESR spectra of larger impurity ions may be seen. It is possible that factors other than size alone are involved. When the size of the substitutional ion is smaller than that of the vacancy and no isotropic spectrum is seen, there are two possibilities. If the ion is only very slightly smaller than the vacancy, it may rattle in random fashion. It it is much smaller, the substitutional ion will tend to be bound close to one of its neigh-

bors and show an axial component of symmetry. For every two trivalent impurity ions incorporated into a II-VI compound, one positive ion vacancy is also incorporated. Positive holes, created by irradiation of crystalline MgO are trapped on oxygen atoms adjacent to such positive ion vacancies, forming V_1 centers. These centers were detected in powders of MgO, CaO and SrO. Although their ESR spectrum is anisotropic, an asymmetric line at its turning point is seen, corresponding to centers with axes oriented nearly perpendicular to the magnetic field. Two kinds of trapped electron centers (F and F_2) are also observed in nearly all the II-VI compounds. (auth)

2470 PARAMAGNETIC RESONANCE OF IRRADIATED CaF_2 CONTAINING RARE EARTH SALTS. W. Hayes and J. W. Twidell (Clarendon Lab., Oxford). p.163-6 of "Paramagnetic Resonance. Vol. I." New York, Academic Press, 1963.

Effects of 50-kv x rays on synthetic undoped CaF_2 and on CaF_2 containing rare earth impurities were investigated using ESR techniques. Irradiations were carried out in a microwave cavity at temperatures between 20°K and room temperatures and the induced electron excess and electron deficient centers were investigated. The structure of the self-trapped hole in CaF_2 was determined and it was shown that rare earth impurity ions which dissolve initially in CaF_2 in the trivalent state on cubic lattice sites provide trapping centers for electrons. Effects of electron irradiations on CaF_2 at room temperature were investigated. (auth)

2471 ESR OF RARE EARTH IONS IN IRRADIATED AND THERMALLY TREATED CaF_2. W. Low (Hebrew Univ., Jerusalem) and U. Ranon. p.167-77 of "Paramagnetic Resonance. Vol. I." New York, Academic Press, 1963.

Single crystals of CaF_2 containing various rare earth ions were irradiated by γ rays and treated thermally. Conversions of trivalent ions to other valencies as well as changes in the point symmetry were observed. (auth)

2472 PARAMAGNETIC RESONANCE OF U^{3+} AND U^{4+} IN CALCIUM AND STRONTIUM FLUORIDE. R. S. Title (International Business Machines Corp., Yorktown Heights, N. Y.). p.178-88 of "Paramagnetic Resonance. Vol. I." New York, Academic Press, 1963.

The substitution of U^{3+} and U^{4+} ions for the divalent cation in CaF_2 or SrF_2 creates a charge unbalance at the cation site. In order for charge neutrality in the crystal to be preserved the presence of compensating negative charges is required. Different orientations of the uranium ions and the compensating charges may lead to different symmetries at the uranium sites. Paramagnetic resonance techniques were used to determine the symmetry at the uranium ions. In addition to the previously observed U^{3+} ions in sites of tetragonal symmetry, U^{3+} ions in sites of cubic symmetry were identified in CaF_2. Observations of U^{4+} ions in trigonal sites were made both in CaF_2 and SrF_2. These centers in CaF_2 were previously attributed by Porto and Yariv to be due to U^{3+}. Both paramagnetic and optical data are presented to show that these centers are in fact U^{4+} ions. A model is given for the U^{4+} site, suggested both from the paramagnetic data and from the details of the chemical preparation of the crystal. The spectrum of Fe^{3+} in cubic symmetry was also observed in CaF_2. (auth)

2473 ELECTRON SPIN RESONANCE AND SPIN-LATTICE RELAXATION FOR THE Yb^{3+} ION IN CdF_2. P. P. Pashinin and A. M. Prokhorov (Lebedev Inst. of Physics, Moscow). p.197-201 of "Paramagnetic Resonance. Vol. I." New York, Academic Press, 1963.

The results of the investigation of the EPR spectrum of Yb^{3+} in CdF_2 are given. The constants of the cubic spin-Hamiltonian were determined at the temperature of 4.2°K and at the frequency of 9100 Mc. The distance to the first excited level Γ_8 was evaluated through the changes of the g-factor of the ground state in high magnetic fields. The value obtained for this splitting was confirmed by the investigation of the temperature dependence of the integral intensity of the EPR line in the region from 4.2 to 60°K. The results of the experiments on the spin-lattice relaxation at temperatures from 2 to 77°K are given. Samples with various Yb concentrations were investigated. In the helium temperature range the relaxation is due to first order processes, and $T_1 \sim T^{-1}$. At higher temperatures the Raman scattering predominates, and at temperatures over 15°K, $T_1 \sim T^{-7}$. (auth)

2474 ELECTRON NUCLEAR DOUBLE RESONANCE IN CALCIUM FLUORIDE CONTAINING DIVALENT EUROPIUM. J. M. Baker, J. P. Hurrell, and F. I. B. Williams (Oxford Univ.). p.202-5 of "Paramagnetic Resonance. Vol. I." New York, Academic Press, 1963.

Single crystals of CaF_2 containing about 0.01% of Eu^{++} exhibit ENDOR transitions in both the europium and fluorine nuclear resonances. The very narrow lines, ~10 kc/s, enable very precise measurements to be made of both hyperfine structure due to interaction between the electrons and the two europium isotopes and also the interaction with the ligand and more distant fluorine nuclei. (auth)

2475 ANGULAR SPECTRA OF $\Delta M = \pm 2$ AND ± 3 TRANSITIONS IN (0.999 La, 0.001 Gd) · $(C_2H_5SO_4)_3 \cdot 9H_2O$. H. A. Buckmaster (Univ. of Alberta, Calgary, Can.). p.217-23 of "Paramagnetic Resonance. Vol. I." New York, Academic Press, 1963.

The magnetic resonance angular spectra for the $\Delta M = \pm 2$ and ± 3 transitions were computed using the published values of the adjustable parameters. Comparison of the calculated spectra with that obtained at frequency of 24GH$_z$ and a temperature of 90°K shows good agreement at all orientations within ±2 gauss. The only exception is the $+\frac{1}{2} \leftrightarrow -\frac{3}{2}$ transition which has a periodicity of 90° instead of 180° and a larger amplitude. No explanation is offered. These measurements indicate that $g_{\parallel} = 1.9910 \pm 0.0005$, $g_{\perp} = 1.9910 \pm 0.0005$, and $a_2^0 = (204.7 \pm 0.5) \times 10^{-4}$ cm^{-1} are improved limits of error on these parameters. (auth)

2476 ENERGY LEVELS OF AND ENERGY TRANSFER IN RARE EARTH SALTS. G. H. Dieke (Johns Hopkins Univ., Baltimore). p.237-52 of "Paramagnetic Resonance. Vol. I." New York, Academic Press, 1963.

Very detailed empirical energy level diagrams of rare earth ions in crystals can be obtained from the analysis of the absorption and fluorescence spectra of these ions. These levels are often essential for a proper interpretation of the paramagnetic resonance data. For the analysis of the energy diagram, theoretical calculations of the free ion energies of the Stark splittings are required which have now been made for all rare earths. The electrostatic crystal field model appears to give a satisfactory account of the splittings. Discrepancies between calculated and observed Stark components can mostly be attributed to inadequacies of the free ion wavefunctions. The breakdown of the electrostatic model accounts for the width of the lines, the appearance of supernumerary lines and relaxation times. The latter can be studied qualitatively through the analysis of the fluorescence spectra with monochromatic excitation. Different lattices behave very differently. For Er^{3+} the ion interacts least with the $LaCl_3$ lattice, most with the hydrated salts, and the garnets and oxides in between. (auth)

2477 THE VALIDITY OF CRYSTAL FIELD THEORY AS APPLIED TO RARE EARTH IONS: AN ANALYSIS OF THE SPECTRUM OF PRASEODYMIUM TRICHLORIDE. J. C. Eisenstein (National Bureau of Standards, Washington, D. C.). p.253-9 of "Paramagnetic Resonance. Vol. I." New York, Academic Press, 1962.

The spectrum of $PrCl_3$ below 25000 cm^{-1} is analyzed from the point of view of crystal field theory. Coulomb, spin-orbit, and crystal field interactions are taken into account. The Coulomb integrals, the spin-orbit coupling constants and the quantities $A_l^m\langle r^l\rangle$ which characterize the crystal field are treated as parameters. The eigenvalue problem for the f^2 configuration is solved by diagonalization of the complete interaction matrices. The calculated positions of the energy levels are compared with the experimental results. This comparison indicates the existence of appreciable interaction between the f^2 and higher configurations. Also it appears that no single set of crystal field parameters will give good agreement between calculated and observed levels for all multiplets. This difficulty may also be ascribable to neglect of configuration interaction. (auth)

2478 CRYSTALLINE FIELD SPLITTINGS IN CERIUM MAGNESIUM NITRATE. M. J. Leask (Clarendon Lab., Oxford); R. Orbach, M. J. D. Powell, and W. P. Wolf. p.261-6 of "Paramagnetic Resonance. Vol. I." New York, Academic Press, 1963.

An analysis of experimental susceptibility and paramagnetic resonance data on cerium magnesium nitrate was made, in terms of an ionic $4f^1$ configuration and a crystalline potential of C_{3v} symmetry. The results are qualitatively similar to Judd's earlier analysis on other rare earth double nitrates, but they indicate even larger sixth degree terms. Possible reasons for this apparent trend are discussed. (auth)

2479 THEORETICAL STUDY OF BLOCKING OF MAGNETIC MOMENT OF RARE EARTH IONS IN GALLATES OF GARNET STRUCTURE. Y. Ayant and J. Thomas (Laboratoire d'Electrostatique et de Physique du Metal, Grenoble, France). p.279-89 of "Paramagnetic Resonance. Vol. I." New York, Academic Press, 1963. (In French)

The Hamiltonian for the crystalline field of a rare-earth ion of given J placed at a 24 c site in a garnet lattice surrounded by an orthorhombic symmetry largely cubic is of the form: $\mathcal{H} = \mathcal{H}_0 + A\{t\,[Y_3^2 + K\,(Y_2^2 + Y_{-2}^2)] + Y_4^4 + k\,(Y_4^4 + Y_{-4}^4) + s\,[Y_3^4 + k'\,(Y_4^4 + Y_{-4}^4)]\}$, the principal term being the term Y. The Landé factors are deduced theoretically in the same way, by the Van Vleck theory, as the magnetic properties by leaving in determinate the parameters of the formula: $A = (2e^2\sqrt{4\pi}\lambda_4\sigma_4\bar{r}_4/3)\,\Sigma_{-1}^{1}\,[Y_0^4(\theta\phi_i)/d_i^5]$. These can be adjusted by comparison with experimental results. In this way the magnetic properties (curves of susceptibility and magnetization at low temperatures, paramagnetic resonance) of Yb, Er, Tb, Nd, and Pr are interpreted. The relative amplitudes of separation between sub-levels are derived as well as the relative importance of the terms of the above formula. Good cross-checks with experimental data are possible. The energies found are distinctly stronger than supposed, and in numerous cases the approximation consistent with taking an invariant Hamiltonian in the cubic symmetry is sufficient. (tr-auth)

2480 STUDY OF THE HYPERFINE STRUCTURE OF Pr^{3+} IONS IN GALLATE OF PRASEODYMIUM. E. Belorizky and Y. Ayant (Laboratoire d'Electrostatique et de Physique du Metal, Grenoble, France). p.290-4 of "Paramagnetic Resonance. Vol. I." New York, Academic Press, 1963. (In French)

Paramagnetic data can be used in a sufficiently precise manner to show the electronic levels of the ion Pr^{3+} $(4f)^2$ $^3H_4$ in gallates. The fundamental electronic level, a singlet, gives rise to a hyperfine structure of the order of several tens of MH_2, among the levels from which one expects to establish transitions. (tr-auth)

2481 EXCHANGE SPLITTINGS OF L-S MULTIPLETS OF RARE EARTH IONS IN CRYSTALS. G: F. Koster (Massachusetts Inst. of Tech., Cambridge) and H. Statz. p.362-72 of "Paramagnetic Resonance. Vol. I." New York, Academic Press, 1963.

The general form of the exchange interaction between rare earth ions and other magnetic ions in crystalline lattice are discussed. It is shown that the ordinary Heisenberg form of the exchange interaction is, in general, not applicable, to these cases. The form of the interaction is presented and used to discuss some of the magnetic properties of rare earth ions in the garnets. (auth)

2482 A THEORETICAL INVESTIGATION OF SOME SPECTROSCOPIC AND MAGNETIC PROPERTIES OF RARE EARTH IONS. A. J. Freeman (Materials Research Lab., Watertown, Mass.) and R. E. Watson. p.373 of "Paramagnetic Resonance. Vol. I." New York, Academic Press, 1963.

Approximate Hartree-Fock calculations are used. Spin-orbit splittings, Slater integrals, crystal-field parameters, and hyperfine interactions are discussed. (R.E.U.)

2483 MUON RESONANCE. Vernon W. Hughes (Yale Univ., New Haven). p.382-96 of "Paramagnetic Resonance. Vol. I." New York, Academic Press, 1963.

The availability of polarized muons and the ability to detect the spin direction, which are provided by parity nonconservation in the decays of the pi meson and the muon, have made possible magnetic resonance experiments on the muon, on muonium, and on mu-mesic atoms. The study of muon magnetism has advanced our knowledge of the properties of the muon, of relativistic and other higher order effects in atomic magnetism including solid state effects, and of nuclear structure. (auth)

2484 SPIN-LATTICE RELAXATION IN SOME RARE EARTH SALTS. P. L. Scott (Clarendon Lab., Oxford). p.399-404 of "Paramagnetic Resonance. Vol. II." New York, Academic Press, 1963.

Measurements of the spin-lattice (i.e., spin-phonon) relaxation rate T_1^{-1} are described for the trivalent rare earth ions Ce, Nd, Pr, and Sm in the double nitrate $[La_2Mg_3(NO_3)_{12}\cdot 24H_2O]$ and for Ce and Nd in the ethyl sulfate $[La(C_2H_5SO_4)_3\cdot 9H_2O]$ in the temperature range $1.4 \le T \le 5°K$. The measurements are made by observing the transient recovery of the microwave paramagnetic resonance signal after a saturating pulse. The frequencies used are $\nu \approx 9.3$ kMc and $\nu \approx 34$ kMc. By varying such parameters as the paramagnetic ion concentration, the isotopic abundance, the crystal size and orientation, and the pulse width, and by noting the shape of the recovery signal, it was established that the observed relaxation rate corresponds in most cases to the true spin-lattice relaxation rate, except for instances of phonon heating. The direct process, $T_1^{-1} \propto T$; the Orbach process, $T_1^{-1} \propto e^{-\Delta/kT}$ and the Raman process $T_1^{-1} \propto T^7$ for non-Kramers doublets and $T_1^{-1} \propto T^9$ for Kramers doublets were observed. Using Orbach's phenomenological approach, theoretical estimates of the relaxation rates were made. For 1% Nd in the ethyl sulfate with $z \perp H$ at $\nu = 9.3$ kMc/sec, $T_1^{-1} = 1.7T + 3.6 \times 10^{-4}T^9$ sec^{-1}, compared with the theoretical estimate $T_1^{-1} = 1.4T + 1.3 \times 10^{-4}T^9$ sec^{-1}. The data, together with similar measurements by others, lead to the overall con-

clusion that spin-lattice relaxation in the rare earths at helium temperatures is reasonably well understood. (auth)

2485 OBSERVATION OF THE PHONON BOTTLENECK. C. D. Jeffries (Univ. of California, Berkeley). p.405-13 of "Paramagnetic Resonance. Vol. II." New York, Academic Press, 1963.

In measurements of the spin-lattice relaxation rate of the trivalent rare earth ions Ce, Nd, Pr, and Sm in lanthanum double nitrate at approximately 1.5°K, the direct process, $T_1^{-1} \alpha T$, dominates. If this process is unusually strong, the spin-phonon coupling may exceed the phonon-bath coupling. The spins then heat the phonons in a narrow band at the frequency ν, and the observed relaxation rate of the spins may be limited by the phonon-bath relaxation rate T_{ph}^{-1}. This so-called phonon bottleneck was envisaged by Van Vleck some time ago. In the course of previous work an exponential decay rate $T_b^{-1} = DT^2$ was observed, where D is proportional to the resonance linewidth ΔH and inversely proportional to the paramagnetic ion concentration N and the crystal thickness l. The measurements are made by saturating the spin resonance by a pulse and observing the transient recovery of the signal after the spin temperature has almost cooled to the bath temperature. Under these conditions it is shown by a simple theoretical argument that one expects an exponential decay rate $\tau^{-1} \propto [\Delta H/NT_{ph}]T^2$ for a severe bottleneck. This is identified with the observed rate T_b^{-1} and thus experimentally the phonon-bath relaxation time T_{ph} is determined. Consistent findings indicate a value close to the time of flight of sound waves through the crystal half-thickness. This suggests that the hot phonons either go into the helium bath or are inelastically scattered into other modes on the first incidence at the crystal boundary; the mechanism is not known. For 1% Pr in the double nitrate the bottleneck is severe, the observed rate T_b^{-1} being $\sim 10^9$ times smaller than the true spin lattice relaxation rate T_1^{-1}. (auth)

2486 LINE BROADENING IN THE EXCITED STATE OF PARAMAGNETIC CRYSTALS. A. Kiel (Johns Hopkins Univ., Baltimore). p.525-34 of "Paramagnetic Resonance. Vol. II." New York, Academic Press, 1963.

The broadening of states in an excited Stark manifold of a paramagnetic ion in a crystal field is discussed. In particular, the direct or single-phonon relaxation process is shown to be a significant factor in causing line broadening in J manifolds of rare earth salts and some states in iron series crystals. The theory of the relaxation process follows that of the well known Van Vleck theory. To compute the vibrating crystal field the crystal field is divided into an empirical part and a part dependent only on the normal mode symmetry. The empirical part may be evaluated in terms of the (known) static crystal field parameters. This method offers some advantages over the phenomenological methods. The theory is applied to the $^1D_2$ state of Pr^{3+} in a cubic host and the $^3P_2$ and $^3P_1$ states of Pr^{3+} in $LaCl_3$ with fairly good results. The $^4T_2$ green band of ruby is also considered with the conclusions that the width of this band is consistent with a simple relaxation mechanism. (auth)

2487 THE CORRELATION OF THE ELECTRON SPIN RESONANCE SPECTRA AND THE LUMINESCENCE PROPERTIES OF SOME MANGANESE ACTIVATED PHOSPHORS. A. Cunliffe, G. F. J. Garlick, and M. N. Jones (Univ. of Hull, Eng.). p.755-63 of "Paramagnetic Resonance. Vol. II." New York, Academic Press, 1963.

The materials investigated were calcium, strontium, and aluminium fluorides, and magnesium oxide, with the manganese impurity either diffused into the materials, or grown into the crystals from the melt. The cathodoluminescence of the calcium fluoride phosphors can be correlated with the electron spin resonance of the Mn^{2+} ion at calcium vacancies. The addition of cerium as sensitizer to this phosphor partially inhibits the development of the hyperfine structure of the Mn^{2+} electron resonance spectrum. The disappearance of the luminescence properties when the phosphor is heated in air corresponds to a disappearance of the Mn^{2+} electron resonance spectrum when the manganese is combined covalently with oxygen which enters the lattice. (auth)

2488 PARAMAGNETIC SPECIES IN IRRADIATED KNO_3. Henry Zeldes (Oak Ridge National Lab., Tenn.). p.764-84 of "Paramagnetic Resonance. Vol. II." New York, Academic Press, 1963.

Single crystals of KNO_3 irradiated with Co^{60} gamma rays at 77°K were studied using electron spin resonance. The spectra of two paramagnetic species, each having hyperfine structure from a single nitrogen nucleus, were measured at 77°K. The principal values of the g-tensors and hyperfine tensors were deduced as well as the directions of their principal axes. One species is believed to be NO_2. The other species is tentatively assigned to NO_3^{-2}. The NO_2 molecules are believed to be undergoing rapid reorientations between two positions in the same anion vacancy which are related by a mirror plane of the crystal. (auth)

2489 THE RELATION BETWEEN THE MAGNETIC SUSCEPTIBILITY, ELECTRON SPIN RESONANCE, AND THE OPTICAL ABSORPTION OF THE E_1' CENTER IN FUSED SILICA. R. A. Weeks and E. Sonder (Oak Ridge National Lab., Tenn.). p.869-79 of "Paramagnetic Resonance. Vol. II." New York, Academic Press, 1963.

Through a series of irradiations with energetic particles followed by light bleaching and heat treatments of several varieties of fused silica, a one-to-one correspondence was found between an optical band at 2120 Å and an electron spin resonance line, g = 2.0006. A comparison was then made between the concentration of centers in this ESR line determined by an ESR comparison technique and the total concentration measured by a magnetic susceptibility method. Agreement indicated that the g = 2.0006 center was the primary one. This center has been called the E_1' center. From the optical absorption and the concentration of centers, its oscillator strength, f, was found to be $f = 0.14 \pm 0.04$. (auth)

2490 THE INFLUENCE OF WALL CONDUCTANCE ON MAGNETOHYDRODYNAMIC CHANNEL-FLOW HEAT TRANSFER. W. T. Snyder (New York Univ., Stony Brook). New York, American Society of Mechanical Engineers, 1963, Preprint Paper 63-WA-136, 5p. (CONF-102-11)

From American Society of Mechanical Engineers 1963 Winter Meeting, Philadelphia, Nov. 1963.

An analysis is made of the influence of finite electrical conductivity of the walls on fully developed magnetohydrodynamic channel-flow heat transfer. The analysis is based on arbitrary external electrical loading and is thus valid for both generator and accelerator modes of operation. Constant properties of the fluid and walls are assumed. It is shown that under certain operating conditions of external electrical loading, the fluid bulk-to-wall temperature difference for conducting walls differs substantially from that for electrically insulating walls. It is also shown that the influence of the wall conductivity on the heat transfer is opposite for the generator and accelerator modes of operation. Representative numerical calculations are presented. (auth)

2491 CHANNEL-FLOW OF CONDUCTING FLUIDS UNDER AN APPLIED TRANSVERSE MAGNETIC FIELD. Apostolos E. Germeles (Arthur D. Little, Inc., Cambridge, Mass.). New York, American Society of Mechanical Engineers, 1963, Preprint Paper 63-WA-56, 5p. (CONF-102-8)

From American Society of Mechanical Engineers 1963 Winter Meeting, Philadelphia, Nov. 1963.

The most general steady state solution is derived for the laminar flow of an incompressible, viscous, and electrically conducting fluid in a one-dimensional channel under an applied transverse magnetic field. The channel can act as an electromagnetic flowmeter or pump. The effect of the conductivity of the walls is included. The solution has two unknown constants and, by choosing them properly, it can be made to fit the solution of all two-dimensional channels whose geometry approaches in the limit that of the one-dimensional channel. This is done in detail for the two-dimensional channels with rectangular and annular cross section. (auth)

2492 ION BEAM PROFILES IN THREE-DIMENSIONAL MAGNETIC FIELDS. A. C. Lilly, Jr. and T. J. Weismann (Gulf Research & Development Co., Pittsburgh). 23p. (CONF-74-23)

From 11th Annual Conference on Mass Spectrometry and Allied Topics, San Francisco, May 1963.

Using the measured values of the three-dimensional magnet field intensity, it is possible by numerical techniques to calculate three-dimensional trajectories for charged particles in these fields. These trajectories (particularly those in the z-x plane) agree qualitatively with what is expected from ideal fringing fields at large values of $\pm\epsilon_2'$ (angle between exit ray and normal to exit sector pole face); however, as ϵ_2' approaches zero, deviations from the ideal field cause greater deviations from predictions of qualitative theories. Also, it is apparent that in the sector magnets normally used in mass spectrometry, there will be z-defocusing instead of z-focusing unless shaped pole pieces are employed to make ϵ_2' very much positive. (auth)

Accelerators

Refer also to abstract 1447.

2493 (AED-C-18-01) AUSGEWAHLTES SCHRIFTTUM NACH SACHGEBIETEN. BESCHLEUNIGER. BIBLIOGRAPHISCHE ZUSAMMENSTELLUNG. (Selected Literature According to Subject Field. Accelerator. Bibliographic Compilation). Wolfgang Mausberg, comp. (Johann-Wolfgang-Goethe-Universität, Frankfurt am Main. Institut für Kernphysik). May 1963. 83p.

Two hundred and eighty-seven references on accelerators, covering the period 1962, are presented according to subject. Author, report number, patent number, and subject indexes are included. (M.C.G.)

2494 (BNL-7378) PERTURBATION TECHNIQUES FOR THE DEFLECTING MODE. H. Hahn and H. J. Halama (Brookhaven National Lab., Upton, N. Y.). Aug. 22, 1963. Contract AT-30-2-GEN-16. 25p.

The perturbation methods used to obtain a relative plot of the electric field and the value of R/Q are described. A method involving radial pulling of dielectric and metallic beads is proposed for the R/Q measurement. The experimental data are shown to agree with the previously presented theoretical predictions. (D.C.W.)

2495 (CEA-2313) LES EFFETS TRANSVERSAUX DE LA CHARGE D'ESPACE DANS LES FAISCEAUX DE PARTICULES ELECTRISEES. (Transversal Effects of the Space Charge in an Electrified Particle Beam). J. Faure, M. Gouttefangeas, R. Levy-Mandel, R. Vienet, B. Lago, and J. Loeb (France. Commissariat a l'Energie Atomique. Centre d'Etudes Nucleaires, Saclay and Compagnie de Geophysique, Montrouge, France). Mar. 1963. 29p.

The repulsive electrostatic forces existing inside a proton beam focused by the magnetic field of a circular accelerator were studied. The general equation that rules the variation of beam density versus time was rewritten by a fairly simple reasoning, and a numerical method to solve the equation was then developed. The optimum beam was then determined, using a gaussian density distribution to obtain an analytical solution to the problem. (auth)

2496 (CERN-63-30) CALCUL ATOMATIQUE DES FAISCEAUX DE π ET DES FAISCEAUX DE μ. PROGRAMME FORTRAN (CERN 6008 B56/57). APPLICATION AU PROJET DE FAISCEAU π-μ DU PS). (Automatic Calculations on π and μ Beams. Fortran Program (CERN 6008 B56/57). Application to the Project of π-μ Beams of the PS). A. Citron, J. Fronteau, and J. Hornsby (European Organization for Nuclear Research, Geneva). Aug. 30, 1963. 93p.

A program for the calculation of the entire beam spectrum produced by a target inside an accelerator and guided by a very general transport system is presented. The program uses the following information: the rate of production of particles as a function of their angle of emission and their momentum, the characteristics of the accelerator field that crosses the particles before the transport system is reached, and the characteristics of this system and of the receiver. The program can be used to calculate the spectrum of the secondary charges emitted in flight by two-body decay and transmitted by the system. The calculation of the π-μ beam, proposed by the CERN-IVRY group for the east zone of the protron synchrotron is shown as an application. (tr-auth)

2497 (NIRL/R/48) A HIGH-SPEED TEMPERATURE MONITORING SYSTEM FOR NIMROD. J. H. Major (Gt. Brit. National Inst. for Research in Nuclear Science. Rutherford High Energy Lab., Chilton, Berks, England). June 26, 1963. 32p.

The transistorized system that monitors water temperatures at points in the accelerator heat removal system is described. The system covers 1600 points and uses thermistors and static switching circuits. (D.C.W.)

2498 (ORNL-3540) A PROPOSAL FOR THE Mc^2 ISOCHRONOUS CYCLOTRON. A GENERAL PURPOSE HIGH-INTENSITY 810-Mev PROTON ACCELERATOR. (Oak Ridge National Lab., Tenn.). Nov. 1, 1963. Contract W-7405-eng-26. 322p.

An isochronous eight-sector proton cyclotron to provide an extracted beam in excess of 100 μamp at 810 Mev is proposed. The primary proton beam and the secondary meson and neutron beams will be used to investigate nuclear structure and the interactions between elementary particles. Biomedical and space-oriented research programs are also planned. Shielded research areas and an extensive beam transport and analysis system are provided. Theoretical and experimental studies have shown that the Mc^2 Cyclotron is a practical concept; high extraction efficiencies can be obtained, and the residual radiation problems are manageable. The project would require less than seven years to complete and would cost about $43,000,000. (auth)

2499 (PPAD-498E) THE HIGH VACUUM SYSTEM USING EPOXY RESIN AND GLASS CLOTH FOR THE PRINCETON–PENNSYLVANIA PROTON SYNCHROTRON. N. Oser and R. Westwig (Princeton–Pennsylvania Accelerator, Princeton, N. J.). Oct. 2, 1963. Contract AT(30-1)-2137. 22p. (CONF-209-6)

From American Vacuum Society Meeting, Boston, Oct. 1963.

The evaluation and selection of an epoxy resin for use in the vacuum system of a proton synchrotron is described. The resin chosen allows routine operations in the pressure range 8×10^{-7} to 2×10^{-6} torr. The design of a vacuum pump system for use with this synchrotron is also described. (T.F.H.)

2500 (TID-19422) THE DEVELOPMENT OF A HIGH-POWER KLYSTRON AMPLIFIER TUBE. Final Technical Report, December 12, 1960–April 28, 1962. A. C. Grimm and A. W. Bachman (Radio Corp. of America. Electron Tube Div., Lancaster, Penna.). For W. W. Hansen Labs. of Physics, Stanford Univ., Calif. Contract AT(04-3)-363; Sub-Contract S-126. 173p.

For Suppl.I, see CAPE-1071.

The tubes developed for testing the klystron tubes and their performance are reviewed; and the design, assembly, and electrical performance of the six klystron tubes fabricated are described. One tube was operated with uniform-field permanent magnet focusing and achieved full performance at the half-power conditions. The maximum peak power attained was 16.7 Mev at 32.4% efficiency. An electromagnet focusing system was used initially to evaluate the tubes. The uniform-field permanent magnet is described, and the tube performance in both focusing systems is compared. Work on the single field reversal focusing system is also summarized. The compression-bond seal technique for fabricating r-f windows was proved practical, and it was demonstrated that high-energy electrons can puncture ceramics. The microwave cold test measurements made on the r-f components are described. (D.C.W.)

2501 (TID-19422(Suppl.II)) THE DEVELOPMENT OF A HIGH-POWER KLYSTRON AMPLIFIER TUBE. SUPPLEMENT II. Final Technical Report, December 12, 1960–April 28, 1962. A. C. Grimm and A. W. Bachman (Radio Corp. of America. Electron Tube Div., Lancaster, Penna.). For W. W. Hansen Labs. of Physics, Stanford, Univ., Calif. Contract AT(04-3)-363; Sub-Contract S-126. 105p.

For Suppl.I, see CAPE-1071.

The assemblies, parts, and detailed processing specifications and schedules for the RCA Developmental Type A1230D (Stanford linear accelerator) klystron are listed. (D.C.W.)

2502 SOME FINE-MECHANICAL CONSTRUCTIONS APPLICATED FOR THE CYCLOTRON OF THE "INSTITUUT VOOR KERNPHYSISCH ONDERZOEK" AT AMSTERDAM. Fijntechniek, 2: 154-64(1962).

A short description is given of the aim and operation of the cyclotron. An enumeration of some constructions destined for the vacuum system is also given. Mentioned are flange sleeves, jointing of flaps, couplings of vacuum pipes, dynamical jointings, pneumatic operation, vacuum flaps, and an automatic steered catch plate holder. (RCN)

2503 SOVIET INDUSTRIAL LINEAR ACCELERATORS. Karel Rytina (Inst. of Vacuum Electronics, Czechoslovak Academy of Sciences, Prague). Jaderna Energie, 9: 235(July 1963). (In Czech)

The problems involved in the development of linear electron accelerators for industrial purposes are being studied. The work includes theoretical studies of the field theory and experimental investigation of the interaction of the particles with the field. On the basis of the results obtained, six linear accelerators, with energies ranging from 2 to 7 Mev, were constructed. These machines were then used for investigating the processes taking place in linear accelerators and for the irradiation of dielectrics. This stage of the program was followed by a program aimed at the development of industrially usable machines, of interest for the national economy. Accelerator No. U-10 was operated at an electron energy of 3 Mev and an average current of 200 μa, yielding a flux of 260 r/min. The amplitude of the accelerating field ranges from 17.4 to 30.0 kv/cm. Accelerator No. U-12 has an energy of 5 Mev, a current up to 100 μa and a radiation intensity of 600 r/min, representing a more reliable version of the previous one. Accelerator No. U-13 possesses an energy of 10 Mev, a current of 70 μa and an intensity of 2500 r/min. Accelerator No. U-16, with a current of 200 μa, can be adjusted from 1 to 2 Mev. (TTT)

2504 BEAM SEPARATION OF K^+ MESONS OF 0.7 TO 1.3 GEV/C. D. Berley (College de France, Paris), J. Duboc, N. H. Duong, et al. Nucl. Instr. Methods, 24: 133-41(Aug. 1963). (In French)

A single stage separated K^+ beam of momentum between 0.7 to 1.3 GeV/c was constructed around a proton synchrotron. The parameters of the beam and the separation obtained are described. The main emphasis was compactness of beam and intensity requirement for bubble chamber experiments. For a circulating beam of 4×10^{10} proton per pulse, the intensity obtained was 2 mesons(K^+) for 10–12 particles at the vertical mass slit for a total $\Delta p/p = 5\%$ and a final image of 5×50 mm^2. (auth)

2505 A MAGNETIC ANALYZER FOR VAN DE GRAAFF ACCELERATORS. P. G. Sona (Laboratori CISE, Milan). Nucl. Instr. Methods, 24: 245-6(Aug. 1963).

The design of a 90° deflection magnet for stabilization of a 4-Mev Van de Graaf accelerator and for bending the beam from a vertical to horizontal direction is presented. The peculiar characteristic of the optics of the magnet is the double focusing for a fixed object and image position. The focusing properties are discussed. (C.E.S.)

2506 LONG X-RAY BURSTS FROM A BETATRON. K. Murray (Naval Research Lab., Washington, D. C.). Nucl. Instr. Methods, 24: 250(Aug. 1963).

A system for producing an x-ray burst of ~150 μsec duration from a betatron is described. The system consists of flat coils placed above and below the orbit. The coils are placed 90° ahead of the target and weaken the field at that point causing the center of the electron orbit to shift towards the target. The circuit used to drive the orbit perturbing coils is illustrated. The advantage of this system is the small amount of energy required to bring about a collision of the beam with the target. (C.E.S.)

2507 OPTIMIZATION OF PARTICLE INJECTION INTO A SYNCHROTRON. A. J. Lichtenberg (Univ. of California, Berkeley). Rev. Sci. Instr., 34: 1196-9(Nov. 1963).

A technique is developed for obtaining the phase space density distribution within the acceptance of a synchrotron if the distribution of the emittance is known. It is shown that the matching of an injector emittance to a synchrotron acceptance depends not only on the phase space boundary but also on the phase space density distribution. The problem of maximizing the charge accepted by a synchrotron with respect to the initial accelerating voltage is consid-

ered. Two cases are treated analytically which, while highly idealized, illustrate the general method and give upper and lower bounds on the voltage. A numerical computation is carried out to obtain the optimum synchrotron voltage at injection for a practical synchrotron injection system. (auth)

2508 BEAM PROFILE MONITOR FOR LINEAR ELECTRON ACCELERATOR. Dowell E. Martz and J. Darrell Robinson (Pacific Union Coll., Angwin, Calif.). Rev. Sci. Instr., 34: 1246-8(Nov. 1963).

The use of a lead sulfide detector in a device for monitoring the intensity distribution of high energy electron beams from a linear accelerator is described. Experimental measurements of the beam profile for a 6-Mev linear accelerator are presented. (auth)

2509 FORMATION OF MAGNETIC FIELD PULSES WITH SHORT FRONTS IN INFLECTOR AND DEFLECTOR DEVICES. [PART] I. I. A. Grishaev, O. G. Ilin, and A. M. Shenderovich (Khar'kov Inst. of Physics and Tech.). Ukr. Fiz. Zh., 8: 861-8(Sept. 1963). (In Russian)

Relations are obtained that should be satisfied by the parameters of an inflector (deflector) magnet for deflecting a beam of charged particles by a given angle. An analysis of these relations was made from the standpoint of obtaining minimal fronts of a magnetic field pulse. An analysis is also carried out for obtaining short fronts for the case when the inductance of the winding is given. Numerical estimates are given for the duration of the fronts. (auth)

2510 FORMATION OF MAGNETIC FIELD PULSES WITH SHORT FRONTS IN INFLECTOR AND DEFLECTOR DEVICES. [PART] II. I. A. Grishaev, O. G. Ilin, and A. M. Shenderovich (Khar'kov Inst. of Physics and Tech.). Ukr. Fiz. Zh., 8: 869-76(Sept. 1963). (In Russian)

An analysis was carried out of the dependence of the duration of magnetic field fronts in an inflector (deflector) device on the pulse-forming circuit and the method of connecting the magnet to the forming line. Methods of fronts are discussed, including parallel connection of winding parts, use of step-up transformers with concentrated and distributed constants, use of shortening dischargers, connection of capacity to the line load. Experimental data are presented. (auth)

2511 THE USE OF AN ON-LINE COMPUTER IN ACCELERATOR EXPERIMENTS. C. Broude (Atomic Energy of Canada Ltd., Chalk River, Ont.). 24p. (CONF-250-7)

From American Physical Society 1963 Summer Meeting in the West, Edmonton, Can., Aug. 1963.

The use of a digital computer in conjunction with an accelerator facility is described. The use of the computer is described with multichannel analyzers; for handling the recorded spectral information; for on-line use without time-sharing; and for on-line use with limited time-sharing. The development of the programs used is discussed. (T.F.H.)

Astrophysics and Cosmology

2512 (LADC-5730) COMMENT ON THE EJECTION OF COMETS FROM THE SOLAR SYSTEM. W. A. Beyer (Los Alamos Scientific Lab., N. Mex.). [1961]. Contract W-7405-eng-36. 3p.

The calculations by Galibina of the postorbits of long-period comets indicate that 10% of the observed comets have been expelled. Consideration of a theorem of Littlewood indicates that this is very unlikely. Capture of material by the solar system from interstellar space is suggested as a possible explanation. (D.C.W.)

2513 (FTD-TT-63-968(p.89-171)) STUDY OF THE MAGNETIC FIELD IN OUTER SPACE. Sh. Sh. Dolginov and N. V. Pushkov. Translated from Kosmich. Issled., 1: No. 1, (July-Aug. 1963).

Experimental data on the magnetic field of the earth, Venus, the moon and interplanetary space obtained with U. S. and Soviet space vehicles are reviewed. 103 references. (D.C.W.)

2514 AN ATTEMPT TO MEASURE THE GALACTIC MAGNETIC FIELD. D. Morris, B. G. Clark, and R. W. Wilson (California Inst. of Tech., Pasadena). Astrophys. J., 138: 889-95(Oct. 1, 1963).

An attempt to measure the galactic magnetic field by the Zeeman splitting of the 21-cm line is described. The observations were confined to the absorption lines in the spectra of Cas A and the Crab Nebula. (C.E.S.)

2515 ON THE RADIOACTIVITY OF STONE METEORITES. M. W. Rowe, M. A. Van Dilla, and E. C. Anderson (Los Alamos Scientific Lab., N. Mex.). Geochim. Cosmochim. Acta, 27: 983-1001(Oct. 1963).

The γ-ray spectra of 37 samples of 25 chondrites, 3 carbonaceous chrondrites, and 9 achondrites were investigated using a large NaI(Tl) scintillation spectrometer. An extensive set of measurements are presented here. Long lived K^{40} and Al^{26} were the predominant radioactivities detected; more unusual γ-ray emitters detected were 308-day Mn^{54}, 2.6-year Na^{22}, and probably a mixture of Sc^{46} and Co^{56+58} (half-lives approximately 80 days). These nuclides were detected in relatively recent falls (the youngest, the Harleton, Texas, chondrite was measured 21 days after fall). Furthermore, thorium was detected and measured in 5 of the 9 achondrites. The average potassium content in chondrites was found to be 0.081 per cent, in excellent agreement with Edwards and Urey. Chondritic potassium concentrations vary ±10 per cent from this average value. The average Al^{26} concentration in stone meteorites was 245 ± 42 disintegrations/min/kg (silicon and aluminum). The variation from the mean of both potassium and Al^{26} concentrations is real, not analytical. (auth)

2516 ON THE RADIOACTIVITY OF IRON METEORITES. M. W. Rowe, M. A. Van Dilla, and E. C. Anderson (Los Alamos Scientific Lab., N. Mex.). Geochim. Cosmochim. Acta, 27: 1003-9(Oct. 1963).

A nondestructive technique employing a large sodium iodide gamma-ray spectrometer was used to examine the gamma radioactivity of iron meteorites. Of 6 studied, only Aroos and Sikhote-Alin showed detectable gamma radioactivity. In Aroos, measured 120 days after fall, 425 ± 40 d/m/kg of 308-day Mn^{54} was the predominant radioactivity detected; 5.27 year Co^{60} concentrations in 4 pieces of Sikhote-Alin ranged from 207 ± 21 to 386 ± 39 d/m/kg. No gamma-ray activity in the energy range 0.2 to 2 Mev was detectable in the other 4 siderites with a limit of detection of about 10 gammas/m/kg. (auth)

2517 NEUTRETTO EMISSION FROM THE STARS. V. DeSabbata and C. Gualdi (Università, Bologna and Istituto Nazionale di Fisica Nucleare, Bologna). Nuovo Cimento (10), 29: 1420-2(Sept. 16, 1963).

The possibility of neutretto emission from photon-photon interactions and photon reactions with nuclei in stars is examined. The intermediate states in the reactions are formed by mesons(μ). The Feynman diagrams are illustrated, and the cross sections are calculated. (C.E.S.)

2518 COSMIC-RAY EXPOSURE AGE OF THE FARMINGTON METEORITE FROM RADIOACTIVE ISOTOPES. J. DeFelice, G. G. Fazio, and E. L. Fireman (Smithsonian Astrophysical Observatory, Cambridge, Mass.). Science, 142: 673-4(Nov. 8, 1963).

The cosmic-ray exposure age of the Farmington meteorite was found to be greater than 7000 years from the ratio of the carbon-14 and argon-39 present and less than 25,000 years from the ratio of the aluminum-26 and argon-39 present. This exposure age is about an order of magnitude smaller than was estimated previously. (auth)

2519 INTERNATIONAL YEARS OF THE QUIET SUN, 1964-65. Martin A. Pomerantz. Science, 142: 1136-43 (Nov. 29, 1963).

The development of the program for scientific investigations during the international years of the quiet sun is outlined. Programs for the investigation of the atmosphere, geomagnetism, aurora, airglow, ionosphere, solar activity, cosmic rays, and geomagnetically trapped particles are briefly discussed. (C.E.S.)

2520 EXPERIMENTAL STUDIES OF GRAVITATIONAL EMISSION OF EXTRATERRESTRIAL ORIGIN. V. B. Braginskii and G. I. Rukman. Vestn. Mosk. Univ., Ser. III, Fiz., Astron., No. 4, 79-83(July-Aug. 1963). (In Russian)

Results are given of preliminary experiments carried out to determine higher limitations for extraterrestrial gravitational emission. (tr-auth)

2521 THE UNIVERSE IN THE LIGHT OF GENERAL RELATIVITY. John Archibald Wheeler (Princeton Univ., N. J.). p.504-27 of "Lectures in Theoretical Physics. Vol. V." New York, Interscience Publishers, 1963.

The dynamics of the universe within the framwork of general relativity is discussed. A model universe composed of curved empty space, the geometry of spacetime and the structure of matter, transmutation of matter into curvature and curvature into matter, the quantum aspect of a geometrodynamical model universe, quantum states for a closed universe, entropy increase during recontraction, and Mach's principle and the origin of inertia are considered. (C.E.S.)

Atomic Physics

Refer also to abstract 2001.

2522 (61-RL-2864-C) A DETERMINATION OF THE COLLISION CROSS SECTION OF SLOW ELECTRONS WITH CESIUM ATOMS. G. J. Mullaney (General Electric Co. Research Lab., Schenectady, N. Y.). Oct. 17, 1961. 13p.

Electrical conductivity measurements in a concentric electrode cell were used to determine the collision cross sections of electrons with cesium atoms. At temperatures between 950 to 1050°K the electron-cesium atom collision cross section was found to be approximately 4 to 5×10^{-15} cm^2. A preliminary analysis gave order of magnitude agreement with experiment. Conductivity experiments with a parallel plate electrode geometry provided substantially the same results. (auth)

2523 (AFCRL-816) EXCITATION OF SPECTRA BY ION BOMBARDMENT. Scientific Report. S. H. Ghosh (Wentworth Inst., Boston). July 1961. Contract AF19(604)-5734. 49p.

Experiments in which spectra were obtained by reactions of H^+, D^+, He^+, Li^+, Ne^+, Ar^+, and H_2^+ with air, He, Ar, H_2, N_2, and O_2 are reviewed. The experimental arrangements are described, and the results are presented and discussed. The mechanisms for the excitation of spectra in gases by ion reactions are also considered. 47 references. (D.C.W.)

2524 ANALYTIC CONSTANTS FOR ATOMIC SCATTERING FACTORS. F. H. Moore (Atomic Energy Research Establishment, Harwell, Berks, Eng.). Acta Cryst., 16: 1169-75(Nov. 10, 1963).

New and revised values of the analytical constants A, a, B, b, and C for both CuKα and MoKα radiation are presented. Analytical constants for atomic scattering factors derived from self-consistent or variational wave functions and from Thomas-Fermi-Dirac statistics are tabulated. (P.C.H.)

2525 DIATOMIC MOLECULES OF ASTROPHYSICAL INTEREST: IONIZATION POTENTIALS AND DISSOCIATION ENERGIES. P. G. Wilkinson (Naval Research Lab., Washington, D. C.). Astrophys. J., 138: 778-800(Oct. 1, 1963).

A critical analysis was made of the ionization potentials and dissociation energies of 148 diatomic molecules and molecular ions that have astrophysical significance. This summary provides useful data for the calculation of molecular abundances and for discussions of dissociation equilibria and ionization processes. It also points out the great need for further experimental and theoretical research. (auth)

2526 TEMPERATURE DEPENDENCE OF EJECTION PATTERNS IN Ge SPUTTERING. G. S. Anderson, G. K. Wehner, and H. J. Olin (General Mills, Inc., Minneapolis). J. Appl. Phys., 34: 3492-5(Dec. 1963).

Atom ejection patterns from the Ge (100) and (110) surfaces were studied for 100 to 800 ev Ne^+, Ar^+, Kr^+, and Xe^+ ion bombardment as a function of target temperature in the range 0 to 350°C. For ion energies below a critical value dependent on the bombarding ion, atom ejection patterns are always observed; while for higher bombarding energies the patterns appear only when the target temperature exceeds a certain value. From these data an activation energy of 1.3 ev for diffusion of defects was obtained. The experimental results indicate that very little damage to the lattice results from ion bombardment when the ion energy stays below a critical value (Ar, Ne: ~200 ev; Kr, Xe: ~400 ev). At higher ion energy the damage becomes more severe and higher target temperatures are required for annealing the damage between subsequent ion collisions. (auth)

2527 RANGE CONCEPTS AND HEAVY ION RANGES (NOTES ON ATOMIC COLLISIONS, II). J. Lindhard, M. Scharff, and H. E. Schiøtt. Kgl. Danske Videnskab. Selskab, Mat. Fys. Medd., 33: No. 14, 1-42(1963).

A theoretical discussion is given of the range of heavy ions with moderate velocity. The treatment is based on the theory of quasi-elastic collisions. The region where electronic and nuclear stopping compete is of particular interest. Use is made of a simple velocity proportional Thomas-Fermi type formula for electronic stopping and a universal approximate differential cross section for scattering. Simplified models of nuclear scattering assuming power law scattering are also included. They turn out to be useful for exploratory computations of various range quantities. The straightforward theory of ranges is studied. Range curves are computed for any atomic numbers of particle Z_1, and substance Z_2. It is found that when nuclear stopping is dominating, a $\rho - \epsilon$ plot gives a universal range energy description. Probability distribution in total range

and various averages are studied in order to assess corrections to measurements when necessary. Similarly, corrections to measurements of projected ranges are obtained. The range correction due to nuclear stopping is obtained for ions of high initial energy. A survey is given of numerous recent measurements of range. They are found to be in fair accord with theoretical results, for energies between 100 Mev (fission fragments) and ~1 kev. (auth)

2528 ULTRASONIC EXCITATION OF NUCLEAR MAGNETIC RESONANCE OF THE COPPER-63 AND COPPER-65 NUCLEI IN A SINGLE CRYSTAL OF COPPER. D. J. Barnes (Imperial Coll. of Science and Tech., London). Nature, 200: 253-4(Oct. 19, 1963).

The nuclear magnetic resonance and the attenuation of an ultrasonic wave due to nuclear spin-level transitions are reported for both Cu^{63} and Cu^{65} in a copper single crystal. The line shape of the ultrasonically induced resonance broadens and the ratio of signal strength to ultrasonic power decreases with increasing transducer voltage, due to saturation of the nuclear spin-levels. The unsaturated line width of the resonance is approximately 25 and 50 gauss for the Cu^{63} and Cu^{65} resonances, respectively. Both lines are shifted to higher field values from that corresponding to the ultrasonic frequency equal to twice the Larmor frequency, by 85 gauss and 170 gauss, respectively. (P.C.H.)

2529 MORSE POTENTIAL PARAMETERS FOR HELIUM. O. P. Bahethi and S. C. Saxena (Rajasthan Univ., Jaipur, India). Phys. Fluids, 6: 1774-5(Dec. 1963).

The three parameters of the Morse potential for helium are determined from data on the viscosity and second virial coefficient as functions of temperature. Computed values of the viscosity, second virial coefficient, thermal conductivity, and the reduced thermal diffusion factor are compared with experimental values. It is concluded that the potential parameters determined from the viscosity can predict the other nonequilibrium properties quite satisfactorily but fail in the case of equilibrium properties. (C.E.S.)

2530 COMPLETE CURRENT-VOLTAGE CHARACTERISTICS OF A SHOCK-HEATED GAS. Hugo K. Messerle and Donald W. George (Univ. of Sydney). Phys. Fluids, 6: 1777-8(Dec. 1963).

Current-voltage characteristics were determined for air at several shock energies in terms of Mach number. The shocks were produced in an electrically driven shock tube with a cylindrical driver. Different probe spacing and areas were used. (C.E.S.)

2531 MEASUREMENTS OF RESONANT ELECTRON CAPTURE IN He^+ ON He COLLISIONS. Grant J. Lockwood, Herbert F. Helbig, and Edgar Everhart (Univ. of Connecticut, Storrs). Phys. Rev., 132: 2078-82(Dec. 1, 1963).

Differential scattering of He^+ ions by He atoms in the energy range of 0.4 to 25.0 kev was studied as a function of scattering angle between 0.4 and 4.4°. The scattered ion was analyzed to determine whether it had captured an electron after a single collision with a target atom. The limits in both energy and angle were chosen in order that a very wide variation in velocity and in impact parameter might be represented by the data. The high angular resolution needed in obtaining data at the small angles placed severe requirements on the beam-defining geometry and made precise determinations of the ion beam direction necessary. In addition, a spreading of the low-energy ion beam, which would have prevented taking data at small angles, was observed. The use of a special high-temperature collision chamber was necessary to prevent this spreading. Besides electron-capture effects, electron stripping and double capture were also studied, as represented by the He^{++} and He^- components among the scattered particles. For this ion-atom combination, electron capture by the ion is a result of resonant charge transfer and the electron capture probability is observed to oscillate when plotted versus incident ion energy. The electron-capture probability, which is found to be independent of scattering angle at the high ion energies, is observed to undergo a transition such that the electron-capture probability oscillates rapidly with angle, and is independent of ion energy at low energies. From these data, relationships among electron-capture probability, scattering angle, and ion energy are found and used to obtain an empirical equation that fits the data. This is the first of two consecutive papers, of which the second, by Everhart, analyzes these data in terms of the theory of resonant electron capture. (auth)

2532 ANALYSIS OF THE He^+ ON He COLLISION. Edgar Everhart (Univ. of Connecticut, Storrs). Phys. Rev., 132: 2083-90(Dec. 1, 1963).

This is the second of two consecutive papers dealing with resonant electron capture in He^+ on He collisions. The first of these, by Lockwood, Helbig, and Everhart, describes differential measurements of electron capture probability P_0 made over a wide range of incident energy and scattering angle. These data are treated within the framework of an improved theory for charge transfer due to Bates and McCarroll. The theory requires a knowledge of the energy levels of the He_2^+ molecular ion at all internuclear distances. Using values of these energy levels given by Lichten, the location of the maxima and minima of P_0 at all impact parameters and velocities is computed. The repulsive potential energy of the He_2^+ system is also calculated here so that these impact parameters can be related to the scattering angle. These results allow the value of P_0 to be predicted over a wide range of impact parameters (0.05 to 1.4 Å), scattering angles (½ to 4°), and energies (0.4 to 1000 kev). There is fair quantitative agreement with the data curves. However, a detailed comparison of theory and data shows discrepancies. At high velocities and low impact parameters there is rather good agreement and there is again fair agreement at low velocities and large impact parameters. In between, however at intermediate impact parameters the data curves are such that the interaction appears to be different depending on whether the velocity is above or below a critical value of about 6×10^7 cm/sec. This behavior of the data is not predicted by the present theory. (auth)

2533 DISSOCIATIVE IONIZATION OF H_2: A STUDY OF ANGULAR DISTRIBUTIONS AND ENERGY DISTRIBUTIONS OF RESULTANT FAST PROTONS. Gordon H. Dunn and L. J. Kieffer (Joint Inst. for Lab. Astrophysics, Boulder, Colo.). Phys. Rev., 132: 2109-17(Dec. 1, 1963).

Protons with energies between 2 and 14 ev were observed from dissociative ionization of H_2 using a rotatable collision chamber in conjunction with a small 60° sector magnetic spectrometer, and using electrons with energies ranging from threshold to 1500 ev. The degree of anisotropy in the angular distribution of protons is found to be dependent on electron energy. The anisotropy is analyzed in terms of selection rules and in terms of electron scattering using an analogy with dissociative excitation. The effects of the anisotropy and its electron energy dependence on measurements of cross sections and the energy distribution of protons is investigated. The energy distribution of protons is measured as a function of electron energy, and quite good agreement is found with predictions of the Franck-Condon

principle. This is in rather sharp contrast with results of previous investigators. (auth)

2534 FIRST-ORDER PERTURBATION CORRECTIONS TO THE HARTREE-FOCK APPROXIMATION FOR HELIUM. A. W. Weiss and J. B. Martin (National Bureau of Standards, Washington, D. C.). Phys. Rev., 132: 2118-22(Dec. 1, 1963).

Variational perturbation theory was used to compute the first-order wave function for the ground state of the helium atom, in a scheme where the Hartree-Fock function is treated as the zeroth-order approximation. The first-order function was approximated by a Hylleraas-like expansion, explicitly containing r_{12}. A total energy is obtained through third order of −2.90262 au, as compared with the nonrelativistic eigenvalue of −2.90372. The first-order corrections to expectation values of a selection of one- and two-electron operators were computed. The calculations were also done for the isoelectronic ions, H^-, Li^+, and Be^{2+} (auth)

2535 PROOF OF MOSZKOWSKI'S FORMULA FOR THE VARIANCE OF TERM ENERGIES IN AN ELECTRONIC CONFIGURATION OF THE FORM l^n. David Layzer (Harvard Univ., Cambridge, Mass.). Phys. Rev., 132: 2125-7 (Dec. 1, 1963).

The formula in question is $\sigma^2(E \text{ in } l^n) = [n(n-1)(4l+2-n)(4l+2-n-1)/2(4l)(4l-1)]\sigma^2(E \text{ in } l^2)$. The proof makes use of probability matrices rather than of fractional parentage coefficients. (auth)

2536 ATOMIC RESPONSE FUNCTION. Werner Brandt (New York Univ., New York) and Stig Lundqvist. Phys. Rev., 132: 2135-43(Dec. 1, 1963).

The response function of atoms is derived approximately within the framework of the time-dependent Hartree scheme for external fields of wavelength large compared to atomic dimensions. Solutions of the resulting dispersion equation correspond to new resonances of atoms. The theory is discussed in terms of the properties of the differential oscillator-strength distribution, or photoabsorption cross section, for the Hartree model and for the statistical model of the atom. An illustrative calculation in the statistical approximation exhibits qualitatively the conditions for the occurrence of these resonances. (auth)

2537 SPIN EXCHANGE IN COLLISIONS BETWEEN ATOMS. A. E. Glassgold (Univ. of California, Berkeley). Phys. Rev., 132: 2144-54(Dec. 1, 1963).

Polarization phenomena in collisions between one-electron (alkali-like) atoms are calculated with density-matrix techniques. The kinetic energies for which this treatment is valid are limited from above by the use of the Born-Oppenheimer approximation, and from below by the assumed degeneracy of the hyperfine states. The basic mechanism for polarization changes is the electron-exchange effect, as suggested by Purcell and Field and by Wittke and Dicke. The special situation of unpolarized targets is treated in some detail. In this case, there are two numbers which characterize the scattering through any angle: the absolute values of certain direct and exchange scattering amplitudes, F_d and F_x. All cross sections must be expressible in terms of $|F_d|$ and $|F_x|$, and this is explicitly carried out in two cases of special interest. One refers to the case in which only the electron-spin polarization is measured, and the other to measurements of the polarization of the hyperfine states of the scattered atom. Effects of the identity of the atoms are also studied in detail. (auth)

2538 EFFECT OF HYDROGEN–HYDROGEN EXCHANGE COLLISIONS. P. L. Bender (Joint Inst. for Lab. Astrophysics, Boulder, Colo.). Phys. Rev., 132: 2154-8 (Dec. 1, 1963).

Exchange collisions between ground-state hydrogen atoms are considered. The density matrix after collision is calculated for pairs of atoms which initially had the same density matrix. The result is applied to the hydrogen maser with the assumption that only exchange collisions and the escape of atoms from the storage bulb influence the linewidth for the field-independent hyperfine transition. Under normal operating conditions a frequency shift of roughly 5% of the exchange collision contribution to the linewidth is predicted. (auth)

2539 COMPUTER STUDIES OF THE SLOWING DOWN OF ENERGETIC ATOMS IN CRYSTALS. Mark T. Robinson and Ordean S. Oen (Oak Ridge National Lab., Tenn.). Phys. Rev., 132: 2385-98(Dec. 15, 1963).

The slowing down of 1- to 10-kev Cu atoms in fcc, bcc, and diamond-structure crystals was investigated by high-speed digital computer techniques, using exponentially screened Coulomb and Born-Mayer potentials to describe the interatomic repulsion. The ranges of these atoms prove to be strongly dependent on their initial directions of motion, the order of ranges being

fcc	[011] > [001] > [111] ≈ isotropic,
bcc	[111] > [001] > [011] > isotropic,
diamond	[011] > [001] ≈ [111] > isotropic.

This orientation dependence of the range, which was also observed experimentally, is a consequence of the tendency of the lattice to focus moving particles into channels bordered by relatively closely packed atomic rows. Inclusion of zero-point vibrations reduces the degree of channeling, but does not modify the order of ranges for fcc. The experimental evidence for channeling and some of its implications for radiation damage theory are discussed. (auth)

2540 MEASUREMENTS OF THE FIRST TOWNSEND IONIZATION COEFFICIENT IN NEON AND HYDROGEN. Lorne M. Chanin and G. D. Rork (Honeywell Research Center, Hopkins, Minn.). Phys. Rev., 132: 2547-53(Dec. 15, 1963).

Measurements were made of the electron-ionization coefficient α/p_0 in neon and in hydrogen over an extended range of E/p_0. In neon the present results at low E/p_0 are in agreement with the values previously obtained by Kruithof and Penning. In hydrogen for E/p_0 values less than those corresponding to the Paschen minimum, the present results are in agreement with those of Rose and other previous investigators. From measurements of the variation of α/p_0 as a function of the electron-collision number, information was obtained concerning whether or not the electrons are in equilibrium with the applied electric fields. (auth)

2541 MOBILITIES OF CESIUM IONS IN CESIUM. Lorne M. Chanin and R. D. Steen (Honeywell Research Center, Hopkins, Minn.). Phys. Rev., 132: 2554-7(Dec. 15, 1963).

Measurements were made of the mobilities of cesium ions using a pulsed-discharge technique. Two ionic species were observed; however, over the entire E/p_0 and p_0 range investigated the fast ion type was dominant. The values are compared with the available theoretical values and also previous experimental results. From the comparison the dominant ion is identified as being Cs_2^+; the less frequently observed ion is believed to be Cs^+. The normalized mobility values corresponding to a gas density of 2.69×10^{19} atoms/cc for Cs^+ and Cs_2^+ are 0.075 and 0.21 cm^2/V sec, respectively, over the temperature range of approximately 579 to 679°K. (auth)

2542 COULOMB SCATTERING WITHOUT ATOMIC EXCITATION FOR 50-, 100-, 200-, AND 400-kev ELECTRONS. J. W. Motz, R. C. Placious, and C. E. Dick (National Bureau of Standards, Washington, D. C.). Phys. Rev., 132: 2558-61(Dec. 15, 1963).

Cross sections for the single scattering without atomic excitation of 50-, 100-, 200-, and 400-kev electrons from thin targets of gold, tin, and copper are experimentally determined at angles ranging from 20 to 110 degrees. These experimental cross sections show good agreement with the Lin, Sherman, and Percus phase-shift calculations for the Mott exact cross section, which was evaluated with an approximate Hartree screening potential for gold and copper. On the other hand, the experimental results show appreciable differences from Born cross section calculations containing Molière screening, particularly for the lowest electron kinetic energy (50 kev) and the largest atomic number (79) and for the region where the momentum transfer to the nucleus (in m_0c units) is less than unity. (auth)

2543 NOTE ON THE LINEARIZED BOLTZMANN INTEGRAL EQUATION FOR RIGID SPHERE MOLECULES. R. Dorfman (Rockefeller Inst., New York). Proc. Natl. Acad. Sci. U. S., 50: 804-6(Nov. 1963).

A theorem for the linearized Boltzmann equation for a gas of hard spheres in the spatially homogeneous case is proved. It is shown that the third iterate of the kernel $G(v,v_1)$ is square-integrable. (C.E.S.)

2544 THE RATIO OF CHARACTERISTIC Kα TO WHITE X RADIATION FROM COPPER AT 30 kv. V. Metchnik. Proc. Phys. Soc. (London), 82: 515-18 (Oct. 1, 1963).

The ratio of the intensity of Kα to white radiation from a copper target x-ray tube is estimated and is found to be almost independent of take-off angle. From these results the efficiency of x-ray production is calculated and is found to be consistent with the expression for efficiency given by Compton and Allison. (auth)

2545 PHOTO-IONIZATION OF HELIUM AND IONIZED LITHIUM. A. L. Stewart and T. G. Webb (Queen's Univ., Belfast). Proc. Phys. Soc. (London), 82: 532-6(Oct. 1, 1963).

The work of Stewart and Wilkinson on the photo-ionization of helium using six-parameter Hylleraas ground state and Hartree-Fock continuum wave functions was extended to higher energies. Agreement to within 10% is obtained with the recent measurements of Baker, Bedo, and Tomboulian over the spectral range 504–180 Å. Results for Li^+ based on the same approximations are also presented. (auth)

2546 CLASSICAL CALCULATIONS FOR IMPACT IONIZATION CROSS SECTIONS. S. S. Prasad and K. Prasad (Queen's Univ., Belfast). Proc. Phys. Soc. (London), 82: 655-8(Nov. 1, 1963).

The reliability of the procedure introduced by Gryzinski for the calculation of the cross sections of atoms and molecules toward impact ionization is assessed with the aid of the available experimental data. It is found that fair success is achieved in many cases, but that in some cases the cross sections are seriously underestimated. (auth)

2547 ELECTRON CORRELATION IN THE GROUND STATE OF HELIUM. P. D. Robinson (Oxford Univ.). Proc. Phys. Soc. (London), 82: 656-63(Nov. 1, 1963).

Coulson and Neilson observed that there exists a relation, which is almost exactly linear, between the error in the energy of the ground state of helium and the mean value of $1/r_{12}$, when these quantities are evaluated using certain approximate wave functions. Mathematical explanation of this relation is presented. The reasoning is based primarily on the virial theorem, and to some extent on perturbation theory. (auth)

2548 FIRST-ORDER SOLUTIONS OF ATOMIC HARTREE-FOCK EQUATIONS. M. Cohen (Univ. of Florida, Gainesville). Proc. Phys. Soc. (London), 82: 778-84(Nov. 1, 1963).

The radial Hartree-Fock equations for all atomic systems up to neon are solved by perturbation methods to first order in powers of the nuclear charge. (auth)

2549 THE MOBILITY OF AN ION IN A FERMI LIQUID. R. C. Clark (Univ. of St. Andrews, Fife, Scotland). Proc. Phys. Soc. (London), 82: 785-93(Nov. 1, 1963).

The mobility of a charged impurity in a Fermi liquid of neutral particles was calculated. A simplified form of the distribution function was used to evaluate the collision integral in Boltzmann's equation. The mobility is found to be proportional to $1/(kT)^2$. A brief discussion of the structure of an ion in He^3 and of the applicability of the calculation is given. (auth)

2550 AN EXPANSION METHOD FOR CALCULATING ATOMIC PROPERTIES. III. THE ^2S AND $^2P^0$ STATES OF THE LITHIUM SEQUENCE. M. Cohen (Univ. of Florida, Gainesville and Queen's Univ., Belfast) and A. Dalgarno. Proc. Roy. Soc. (London), Ser. A, 275: 492-503(Oct. 29, 1963).

An expansion method is used to calculate the expectation values of various operators for the lowest ^2S and $^2P^0$ states of all members of the lithium sequence. The method is extended to the calculation of matrix elements connecting the two states, and the electric dipole transition integrals are calculated. A comparison with the results of more refined calculations shows that despite its simplicity the method is capable of high accuracy. (auth)

2551 COMMENT ON THE THEORY OF TRANSPORT COEFFICIENTS. James A. McLennan, Jr. (Lehigh Univ., Bethlehem, Penna.). Progr. Theoret. Phys. (Kyoto), 30: 408-9(Sept. 1963).

An ambiguity in the theory of transport coefficients is discussed. It is shown that the flux of energy density, particle number, charge, or momentum is not uniquely determined from the steady-state transport coefficient. The fluxes are arbitrary to the extent that any quantity with vanishing divergence can be added to them. (C.E.S.)

2552 TWO-TERM APPROXIMATION IN THEORY OF HEAVY PARTICLE COLLISIONS. G. V. Dubrovskii. Vestn. Leningr. Univ., No. 10, Ser. Fiz. i Khim., No. 2, 16-23(1963). (In Russian)

The dependence of transition probability on analytical properties of molecular functions L_{12} and ω is discussed in terms of the two-term approximation. An integral equation for the transition coefficient was obtained. Conclusions concerning the dependence of the transition probability on the velocity of the colliding particles are presented. (C.E.S.)

2553 SOME DYNAMICAL PROPERTIES OF SURFACE ATOMS. A. A. Maradudin and J. Melngailis (Westinghouse Electric Corp., Pittsburgh). 22p. (CONF-303-1)

From 3rd International Conference on the Mössbauer Effect, Ithaca, N. Y., Sept. 1963.

Expressions for the mean square velocity and mean square amplitude of an atom in the surface layers of a simple cubic crystal are obtained using double time Green's functions. They are evaluated explicitly in the high temperature limit. The hamiltonian of the unperturbed crystal is

taken in the harmonic approximation with nearest and next-nearest neighbor central force interactions between the atoms. The perturbation produces free surfaces by subtracting all the interactions (or bonds) that cross a certain plane. The exponential in the Debye-Waller factor for a surface atom calculated to lowest order in inverse temperature is twice as large as its bulk value for γ-ray emission perpendicular to the surface and about 30% larger than the bulk value for emission parallel to the surface. These surface corrections decay very rapidly as one goes into the crystal from the surface. In the 5th atomic layer the exponential in the Debye-Waller factor is within 5% of the bulk value. In the second order Doppler shift the effect of the surface is to reduce the second order term in inverse temperature (first quantum correction) by about 30%. The lowest order term is unaffected. If the crystal is made isotropic in the long wavelength, continuum, limit, surface waves that are the classical Rayleigh waves appear. (auth)

2554 STATUS REPORT ON DEVELOPMENT OF A HIGH-SPEED HIGH-INTENSITY MOLECULAR BEAM. Eldon L. Knuth (Univ. of California, Los Angeles). 79p. (CONF-290-1)

From Conference on Molecular and Atomic Gas Beams, Charlottesville, Va., May 1963.

Status of a high-speed high-intensity molecular beam under development is described. Bases for designs of the several components are presented. Using an arc-heated source and a hypersonic jet, molecular energies exceeding 1 ev and beam intensities of the order of 10^{16} molecules/cm^2 sec are anticipated. A two-disk beam chopper and speed selector provides a means for analyzing the speed distribution in the generated beam, for chopping the beam into bursts of nearly monoenergetic molecules suitable for scattering studies using the time-of-flight technique, and for modulating the beam in order to facilitate detection. A through-flow ionization detector possesses the versatility required for scattering studies using the time-of-flight technique. A sorption pump and a turbo pump serve as central components of alternative pumping systems for the collimating chamber. Using the arc-heated source, the converging nozzle, the conduction-radiation-cooled skimmer, the turbo pump (turning at 3400 rpm), the chopper-selector (acting only as a chopper), and the detector, an arc-heated beam is generated and detected. (auth)

Cosmic Radiation

2555 (CRGP-1165) ASYMPTOTIC DIRECTIONS OF APPROACH OF VERTICALLY INCIDENT COSMIC RAYS FOR 85 NEUTRON MONITOR STATIONS. C. J. Hatton and D. A. Carswell (Atomic Energy of Canada Ltd. Deep River Lab., Ont.). Aug. 1963. 96p. (AECL-1824)

The asymptotic directions of approach for vertically incident cosmic rays in a high-degree simulation of the geomagnetic field were calculated. The calculations were made for standard sets of rigidities that are convenient for further computation. The results for 85 cosmic ray stations are presented both in tabulated and in graphical form. (auth)

2556 (FTD-TT-63-968(p.316-20)) RADIATION MONITORING DURING THE FLIGHT OF VOSTOK-3 AND VOSTOK-4. I. A. Savenko, N. F. Pisarenko, P. I. Shavrin, and V. E. (Ye.) Nesterov. Translated from Kosmich. Issled., 1: No. 1, (July-Aug. 1963).

Radiometers on the two vehicles monitored the doses received by the cosmonauts. The average absorbed dose rate was 10 tissue mrad/day, and the total absorbed doses for the flights were 67 and 50 tissue mrad. The contributions to the doses are discussed. (D.C.W.)

2557 (FTD-TT-63-968(p.308-15)) THE RADIATION SITUATION IN SPACE ON THE EVE OF THE FLIGHT OF VOSTOK-3 AND VOSTOK-4. I. A. Savenko, P. I. Shavrin, V. E. (Ye.) Nesterov, N. F. Pisarenko, and M. V. Tel'tsov. Translated from Kosmich. Issled., 1: No. 1, (July-Aug. 1963).

The results of the radiometric measurements obtained with the Cosmos-4 -7, and the apparatus is briefly described. (auth)

2558 GROUND LEVEL COSMIC RAY STARS AT LATITUDE 13° 46′ (N). Charoen Dharmaphanija and Thaworn Suttipongse (Chulalongkorn Univ., Thailand). J. Natl. Res. Council Thailand, 3: 117-26(June 1962).

Ilford G5 Nuclear emulsion plates of thickness 300 microns and size 3″ × 4″ sent by air to Latitude 13° 46′ 12″ N, Longitude 100° 30′ 58″ E were kept at ground level which is approximately equal to sea level. A portion of the plates was developed to determine cosmic ray events during transportation and subsequent storage. The rest of the plates were then developed in one month intervals to determine the increase of cosmic ray stars. The total rate of production of stars in two months and the rate of production of star greater than 2 prongs were found to be 14.3 ± 1.0 stars per cc per day and 12.9 ± 1.3 stars per cc per day respectively. The frequency distribution of tracks produced by stars was found to be in agreement with other measurements at locations of higher latitudes and altitudes. The size distributions of stars caused by ionizing and non-ionizing particles were also found to be in agreement with Le Couteur's extension of the evaporation theory. (auth)

2559 LARGE SPARK CHAMBER AS CORE ANALYZER FOR EXTENSIVE AIR SHOWERS. P. K. F. Grieder (Universität, Bern). Nuovo Cimento (10), 26: Suppl. No. 2, 271-8(1962).

An air shower experiment is described using a large-area air spark chamber as core analyzer, in connection with nuclear emulsions. The apparatus is capable of resolving multiple cores and permits efficient location of soft cascades in the emulsion. The possibility of identifying the nature of the primary particles that initiate the showers by means of analyzing the structure of the core is discussed. A set of data is presented. (auth)

2560 ULTRA-HIGH-ENERGY NUCLEAR INTERACTIONS AND EXTENSIVE AIR SHOWERS. W. M. Glencross (Imperial Coll. of Science and Tech., London). Proc. Phys. Soc. (London), 82: 501-14(Oct. 1, 1963).

The kink in the size spectrum of extensive air showers occurs at a similar size at all altitudes, although shower absorption measurements indicate that there is an attenuation of particle numbers with depth. It follows that the cause cannot be the shape of the primary energy spectrum, but must lie in the properties of nuclear interactions. A model in which the elasticity of nuclear interactions increases from about 0.5 to 0.7 as the interaction energy becomes greater than 5×10^{13} ev is proposed. The mean energy of the secondary pions is also supposed to increase. As a result, in small showers the individual electron-photon cascades are short, and large fluctuations in development can occur, whereas for large showers the fluctuations are small. The model is shown to be consistent with most of the experimental evidence, including the size spectrum kink, a decrease in the degree of fluctuation in certain measurements as shower size increases, and a rapid change in the properties of the shower core. (auth)

2561 DETERMINATION OF INTEGRATED SPACE-RADIATION FLUXES DURING AN ORBITAL TRAJECTORY BY ANALOG TECHNIQUES. W. H. Steigelmann and E. W. Jones (Franklin Inst., Philadelphia). Trans. Am. Nucl. Soc., 6: 433-4(Nov. 1963).

2562 NUCLEAR INTERACTIONS OF COSMIC RAY HIGH ENERGY PARTICLES WITH LIQUID SCINTILLATOR. Shih-wei Wang, Hao-hwai Kuang, and Yu-kuei Yuan. Wu Li Hsueh Pao, 19: 205-14(Apr. 1963). (In Chinese)

Nuclear interactions induced by high-energy cosmic particles were studied by means of a multiplate cloud chamber at 3,185 meters above sea level with liquid scintillator as target material. From the analysis of 18 interactions induced by charged primaries it is found that average primary energy $\overline{E}_0 = 41 \pm 8$ Bev, average multiplicity of charged secondaries $\overline{n}_s = 4.9 \pm 0.3$, and with $x = \lg \gamma_c \operatorname{tg} \theta_1$ the differential angular distribution (dN/dx) indicates some possibility of the existence of double-humped shape. This angular distribution was discussed tentatively among the lines of two-centered model. (auth)

2563 COSMIC RAY INSTRUMENTATION. William C. Bartley (Southwest Center for Advanced Studies, Dallas). 33p. (CONF-307-2)

From Canadian Electronics Conference, Toronto, Sept.-Oct. 1963.

The use of neutron monitors, balloon airborne detectors, and deep probes to determine the nature of cosmic radiation is discussed. The trajectories of cosmic particles with respect to the geomagnetic field, the solar field, and the initial particle energy and direction are described. The interpretation of the data obtained with the detectors mentioned is outlined. (T.F.H.)

Criticality Studies

2564 (DL-55) A PERSPECTIVE ON DIRECT CONVERSION. W. B. Lewis (Atomic Energy of Canada Ltd. Chalk River, Ont.). Oct. 1963. 12p. (AECL-1852; CONF-307-1)

From Canadian Electronics Conference, Toronto, Sept.-Oct. 1963.

The objective of direct conversion is high electrical output for minimum total cost, and not always high conversion efficiency. The wide range of techniques embracing cryogenics and hot plasma derives from the special requirements of source, environment, and application. Sources include solar and other radiation, nuclear fission and fusion, chemical energy, and heat. Environments and applications range from space vehicles to submarines and from giant power networks to isolated buoys and pocket devices. (auth)

2565 (ORNL-TM-719) CRITICAL THREE-DIMENSIONAL ARRAYS OF NEUTRON-INTERACTING UNITS. J. T. Thomas (Oak Ridge National Lab., Tenn.). Oct. 1, 1963. Contract [W-7405-eng-26]. 13p.

As many as 125 five-liter units of concentrated aqueous uranyl nitrate solution were assembled in critical arrays. The solution, at a concentration of 415 g of uranium per liter, and having a specific gravity of 1.555, was contained in right circular cylinders of methacrylate plastic having a 0.64-cm-thick wall. The U^{235} content of the uranium was 92.6 wt %. The dependence of the number of units required for criticality as a function of the spacing was determined. The critical number, N, as a function of spacing, within the range of these experiments, has been determined to be $N = N_0(\rho/\rho_0)^{-s}$, where N is the number of units in the critical array, ρ and ρ_0 are, respectively, the uranium density in the array and in the unit, and N_0 and s are constants depending upon the neutron reflector surrounding the array. For arrays with no reflector N_0 and s are 2.506 ± 0.014 and 1.928 ± 0.028. Experiments with 8 and 27 unit arrays at lower U^{235} concentration indicate that the value of s increases and that of N_0 decreases with decreasing concentration. (auth)

2566 (WCAP-1818(Vol.I)(Del.)) DESIGN STUDY OF PORTABLE THERMOELECTRIC NUCLEAR SYSTEMS. L. Chajson, A. R. DelCampo, H. B. Kellogg, et al. (Westinghouse Electric Corp. Atomic Power Dept., Pittsburgh). July 1961. Contract AT(30-1)-2176. 199p.

Design studies were performed and costs were estimated for an air transportable, 10 Mw(t), pressurized light water thermal circulation reactor, combined with a direct conversion thermoelectric generator and static electrical inversion equipment. This "TCR-TE" concept appears to have potential for ultimate use as a remote unmanned power station. Based on an extrapolation of present reactor technology and on assumed thermoelectric materials properties forecasted to January 1, 1963, a net a-c electrical output of 315 Kw is estimated, assuming the use of 80°F local water for cooling purposes. An alternate concept using 80°F air for cooling produces 271 Kw, net. These electrical output figures can be improved significantly through a recommended research and development effort. The design and construction of a prototype plant is also recommended. (auth)

2567 THE HOT CRITICAL ASSEMBLY "CÉSAR." P. Tanguy (CEA, Paris). Energie Nucl., 5: 349-54(July-Aug. 1963). (In French)

With César, the Cadarache Center for Nuclear Studies will be equipped with a zero-power critical assembly, which will enable it to obtain the data necessary for the development of natural uranium, graphite, gas reactors. Reactivity balance, evolution of the reactivity, and deformation of the flux curves are to be studied. These studies will complement those already being done on Marius, but carried out at room temperature; in César the graphite temperature can reach 500°C. (auth)

2568 DEVELOPMENT OF AN ADVANCED THERMIONIC CONVERTER FOR NUCLEAR REACTOR EXPERIMENTS. J. T. Ream and J. W. Holland (General Atomic Div., General Dynamics Corp., San Diego, Calif.). Trans. Am. Nucl. Soc., 6: 317-18(Nov. 1963).

Direct Energy Conversion

2569 (ANL-6687(p.188-203)) ENERGY CONVERSION. (Argonne National Lab., Ill.).

Progress is reported on the development of regenerative emf cells and thermoelectric cells for the direct conversion of nuclear energy into electricity. (D.L.C.)

2570 (ASD-TDR-62-411(Pt.II)) ELECTRODELESS MHD GENERATOR RESEARCH. PART II. LABORATORY FACILITY AND EXPERIMENTAL RESULTS. (Radio Corp. of America. Missile and Surface Radar Div., Moorestown, N. J.). Jan. 31, 1963. Contract AF33(616)-7913. 109p. (AD-403369)

The feasibility of a-c electrodeless magnetohydrodynamic power generation was investigated using a model generator. The laboratory facility implemented for the project and the measurement devices and techniques are described in addition to the model generator. The electrical and aerodynamic results obtained are presented. Power generation was observed, and the power extracted from the operating generator was measured. (D.C.W.)

2571 (BSD-TDR-63-196) A HALL GENERATOR WITH WIRE ELECTRODES. Research Report 165. A. W. Carlson (Avco Corp. Avco-Everett Research Lab., Everett, Mass.). Sept. 1963. Contract AF04(694)-33. 16p. (AD-421992)

For a Hall generator, wire electrodes that extend entirely across the interior of the channel seemingly provide the best contact with the hot gas in the free stream. The wire electrodes lie in one or more planes perpendicular to the magnetic field, each wire being perpendicular to the direction of the gas flow. The electrical performance of a Hall generator with this geometry is calculated and found to depend on the Hall parameter, $\omega\tau$, and on the height to width ratio of the channel cross section. There are indications that the performance of these electrodes is nearly equivalent to the performance of wire electrodes which penetrate the wall boundary layer but do not extend entirely across the channel. (auth)

2572 (JUL-Bibl-1) THERMIONIK. EINE LITERATURZUSAMMENSTELLUNG. (Thermionics. A Literature Search). D. Wickmann (Kernforschungsanlage, Julich, Germany). Aug. 1963. 21p.

A collection of 239 references covering the period 1958 to July 1963 on thermionic cells is presented. The references are arranged in categories by subject and subcategories by year. (M.C.G.)

2573 (NP-13299) FUNDAMENTAL STUDIES OF THE CESIUM ARC-MODE THERMIONIC CONVERTER. Annual Technical Summary Report, May 1, 1962–May 31, 1963. Fred M. Johnson (Radio Corp. of America. RCA Labs., Princeton, N. J.). Contract NONR-3826(00)FBM. 100p.

An experimental study using optical and electrical techniques relating to the fundamental processes associated with the high-pressure ($\sim \frac{1}{2}$–2 torr), low-voltage cesium arc thermionic converter is described. Seven different optical methods were employed in this study. Impurities present in the cesium vapor were analyzed by means of a mass spectrometer and the effects of gas additives were investigated. Hydrogen gas is the most damaging impurity since it causes an increase in the electron temperature and participates in hydrocarbon synthesis. A theory of the arc-mode operation was developed based on the optical results. The predicted I-V curve is in good agreement with the experimental results. The measured electron temperatures were in the 1750–2200°K range. A discussion of the ionization mechanism is given. Ionization by cumulative processes involving excited molecular cesium molecules is favored from an energy standpoint. (auth)

2574 (WCAP-1818(Vol.II)(Del.)) DESIGN STUDY OF PORTABLE THERMOELECTRIC NUCLEAR SYSTEMS. L. Chajson, A. R. DelCampo, H. B. Kellogg, et al. (Westinghouse Electric Corp. Atomic Power Dept., Pittsburgh). July 1961. Contract AT(30-1)-2176. 170p.

The design of a thermal circulation reactor with thermoelectric elements is considered. Topics covered include: recommended research and development programs, cost analysis, alternate concepts considered, generator control considerations, thermal and hydraulic analysis, thermoelectric performance calculations, possible design improvements and advancements, procedure use for reactor core thermal and hydraulic calculations, and thermoelectric material properties and technology. (M.C.G.)

2575 TRANSIENT STARTUP PHENOMENA IN PLASMA THERMIONIC ENERGY CONVERTERS. J. S. Chivian, Texas Instruments, Inc., Dallas). Advan. Energy Conversion, 3: 565-8(July-Sept. 1963).

The slow approach to equilibrium operation in a plasma diode was previously ascribed to permeation of the hot refractory emitter by the alkali vapor. A dual diode was used to show that this transient behavior is controlled by the rate of arrival of the alkali vapor into the main interaction region, and by the adsorption of the vapor onto the walls of the enclosure. (auth)

2576 ELECTRIC PROPULSION AND POWER. John M. Teem (Electro-Optical Systems, Inc., Pasadena, Calif.), and George C. Szego. Astronaut. Aerospace Eng., 1: 98-103(Nov. 1963).

Progress in electric propulsion systems, thrustor research and development, applications, and mission analysis are discussed. Some types of electric power systems and their applications are presented. These include solar cells and collectors, the SNAP program, radioisotope systems, thermoelectric and thermionic technology, MHD power, batteries and fuel cells, and power conditioning. (R.E.U.)

2577 EXPERIMENTAL STUDY OF THE IGNITED MODE IN CESIUM THERMIONIC CONVERTERS. S. Kitrilakis (Thermon Electron Engineering Corp., Waltham, Mass.) and E. N. Carabateas. IEEE (Inst. Elec. Electron. Engrs.) Trans. Commun. Electron., No. 66, 263-6(May 1963).

A variable spacing cesium thermionic converter of planar geometry was tested under different conditions of emitter temperature, cesium pressure, and interelectrode spacing. It was found that at low emitter temperatures of the order of 1,300 to 1,400°C, high-power densities in the range of 2 to 4 watts/cm^2 can be obtained with a molybdenum emitter. The performance under these conditions corresponds to an ignited mode where ions are introduced by a different mechanism than surface ionization. (auth)

2578 MITIGATION OF OPEN-CIRCUIT FAILURES IN THERMIONIC REACTORS. William J. Levedahl (Martin Co., Baltimore). Trans. Am. Nucl. Soc., 6: 321(Nov. 1963).

2579 COMPARISON BETWEEN TEST AND CALCULATIONS OF NON-EQUILIBRIUM IONIZATION CONDUCTIVITIES AND THE CORRESPONDING INTERNAL ELECTRIC FIELDS REQUIRED. M. E. Talaat (Martin Marietta Corp., Baltimore). 12p. (CONF-24-19)

From 4th Symposium on Engineering Aspects of Magnetohydrodynamics, Berkeley, Calif., Apr. 1963.

A comparison between the calculated and measured values of the electric conductivity and the corresponding electric fields required in a gas-filled diode containing helium seeded with cesium is presented. The calculations are based on the theory of non-equilibrium ionization in which the electron or ion density in the plasma is derived from an ion balance equation that equates the rate of ion generation by hot electrons in the plasma to the rate of ion loss by recombination. The electric field required to maintain the hot electrons in the plasma is derived from an energy balance equation that equates the rate of energy lost by the electrons in elastic and inelastic collisions with the gas to the rate of energy fed to the electrons through the electric field. (C.E.S.)

2580 NUCLEAR THERMIONIC SPACE POWER SYSTEMS. R. C. Howard and N. S. Rasor (Thermo Electron Engineering Corp., Waltham, Mass.). 62p. (CONF-286-1)

From 18th Annual IAS Propulsion Meeting, Cleveland, Mar. 1963.

The various concepts for utilizing thermionic conversion in space reactor power plants are described and evaluated. The problems (and progress toward their solution) of the in-core concept, particularly, are considered. Progress

in thermionic conversion technology is then reviewed from both the hardware and research points of view. Anticipated progress in thermionic conversion and the possible consequences for the performance of electrical propulsion systems are summarized. 46 references. (D.C.W.)

Elementary Particles and Radiations

2581 (AD-299108) EVIDENCE FOR THE REACTION $\pi^- + p \rightarrow \bar{p} + d$ AND SOME METHODS OF INVESTIGATION VIRTUAL NUCLEON EXCHANGE PROCESSES. Technical Report No. 9. C. C. Ting, L. W. Jones, and M. L. Perl (Michigan. Univ., Ann Arbor). Mar. 1963. Contract 1223(24). 16p.

An examination of data on elastic π-p scattering gave a total cross section of 16 ± 10 μb at 4.13 Bev/c and 8 μb at 4.95 Bev/c for the interaction $\pi^- + p \rightarrow \bar{p} + d$. The data are compared with a perturbation theory calculation, and the possibility of using this interaction to study virtual nucleon exchange at high energies is considered. Two other methods for studying such exchange, backward elastic π-N scattering and the interaction $p + p \rightarrow d + \pi^+$, are compared. (D.C.W.)

2582 (AFCRL-63-80) CERENKOV RADIATION FROM A CHARGED PARTICLE IN UNIFORM STRAIGHT MOTION THROUGH A PARTICULAR STRATIFIED MEDIUM. Technical Note No. 2. L. Ronchi and A. M. Scheggi (Italy. Consiglio Nazionale delle Ricerche. Centro di Studio per la Fisica delle Microonde, Florence). Nov. 1962. 42p. (AD-401865)

A stratified medium constituted by a number of thin, plane, parallel, and equispaced metallic films is considered. The spacing between the films is filled with a perfect dielectric. A charged particle with a velocity above the Cherenkov threshold for the dielectric goes through the structure, normally to the films. The expression of the radiation is worked out as a function of different parameters. The radiation pattern is plotted in a number of particular cases. They indicate that such a system would not produce submillimeter power with reasonable efficiency. (auth)

2583 (CEA-2259) ÉTUDE EXPÉRIMENTALE DES RÈGLES DE SÉLECTION DÉCOULANT DE L'EXISTENCE DE DEUX TYPES DE NEUTRINOS. (Experimental Study of Selection Rules Following From the Existence of Two Types of Neutrinos). Jean-Marc Gaillard (France. Commissariat à l'Énergie Atomique. Centre d'Études Nucléaires, Saclay). 1963. 75p.

Thesis submitted to Université, Paris.

Interactions of high energy neutrinos with matter were observed in an experiment at the Brookhaven AGS. The neutrinos were produced mainly in the decay $\pi^+ \rightarrow \mu^+ + \nu(\bar{\nu})$; the experiment leads to the conclusion that these neutrinos are very likely different from the ones produced in beta decay reactions. The results of the experiment are used to study the selection rules applicable in the framework of a two neutrino theory. (auth)

2584 (CONF-122-16) THEORY OF PROTON COMPTON SCATTERING. A. C. Hearn (Stanford Univ., Calif. Inst. of Theoretical Physics); and E. Leader (California. Univ., Berkeley. Lawrence Radiation Lab.). [1963]. 9p.

From International Conference on Nucleon Structure, Stanford, Calif., June 1963.

The preliminary results of a quantitative calculation of the differential cross section for proton Compton scattering using a previously reported fixed angle dispersion relation formalism are discussed. A relatively large two-spin exchange contribution is indicated. (auth)

2585 (ISS-63/37) RELAZIONE SULL'ATTIVITÀ DEI REPARTI 1° E 2° DEI LABORATORI DI FISICA (SOTTOSEZIONE "SANITA" ASSOCIATA ALL'INFN) NEL 1962-63. (Progress Report of the Sanità Subsection of the INFN During the Period 1962-63). (Italy. Istituto Superiore di Sanità, Rome). June 18, 1963. 27p.

Research dealt with meson(π^0) photoproduction, the lifetime of mesons (π^3) in flight, neutron spectra following meson(π^-) absorption at rest in nuclei, fluorescence yield and coherent scattering in the interaction of 662-kev gamma rays with bound electrons, and the interaction of positrons at rest with matter. Technological development included techniques for high precision measurements of radioactivity, an acoustic spark chamber, and equipment for nuclear physics and for track chamber scanning. Numerical tables of the kinematics of multiple meson photoproduction were calculated, and programs were prepared for the IBM 7040 computer. (D.C.W.)

2586 (JINR-P-1327) RELYATIVISTSKOE URAVNENIE DLYA S-MATRITSY V p-PREDSTAVLENII. I. USLOVIYA UNITARNOSTI I PRICHINNOSTI. (A Relativistic Equation for the S-Matrix in the p-Representation. I. Unitarity and Causality Conditions). V. G. Kadyshevskii (Joint Inst. for Nuclear Research, Dubna, U.S.S.R. Lab. of Theoretical Physics). 1963. 13p.

A covariant formulation of the scattering matrix theory in the p-representation is given. The unitarity and causality conditions are included. (auth)

2587 (JINR-P-1328) RELYATIVISTSKOE URAVNENIE DLYA S-MATRITSY V p-PREOSTAVLENII. II. TEORIYA VOZMUSHCHENII. (A Relativistic Equation for the S-Matrix in the p-Representation. II. Perturbation Theory). V. G. Kadyshevskii (Joint Inst. for Nuclear Research, Dubna, U.S.S.R. Lab. of Theoretical Physics). 1963. 14p.

The covariant equation of motion previously obtained for the scattering matrix is investigated in the framework of perturbation theory. A specific diagram technique is developed. (auth)

2588 (KFK-168) KINEMATIK DER e-p-STREUUNG MIT DER ERZEUGUNG EINES PIONS IM BEREICH VON 3 BIS 6 Gev ELEKTRONENENERGIE. (Kinematics of e-p Scattering with Pion Production in the Range of 3- to 6-Gev Electron Energy). S. Galster and G. Hartwig (Kernforschungszentrum. Institut für Experimentelle Kernphysik, Karlsruhe, Germany). Aug. 1963. 35p.

The kinematics of inelastic processes were described and a review given of the possibilities for the separation of elastic and inelastic scattering processes. The kinematics of elastic and inelastic e-p scattering, in which one pion was produced, were compared. Therefore only scattering on hydrogen was considered. The inelastic processes can be completely separated by pulse analysis of the electrons. The approximation calculation shows that a pulse analysis of the back-scattered protons is not sufficient for the quantitative separation of the inelastic scattering. Inelastic scattering fractions cannot be completely excluded ever with an accurate determination of the direction of scattered electrons and protons. The results of the calculation were applied to detection methods, especially spark chambers. (tr-auth)

2589 (LNF-62/66) MESURE DU RENDEMENT DE CONVERSION NEGATON-POSITON. (Measuring the Yield of Electron-Positron Conversion). Note No. 154. M. Bern-

ardini, J. Miller, C. Schuhl, G. Tamas, and C. Tzara (France, Commissariat à l'Énergie Atomique. Centre d'Études Nucléaires, Saclay and Italy. Comitato Nazionale per l'Energia Nucleare. Laboratori Nazionali, Frascati). Aug. 2, 1962. 18p.

Electron-positron conversion yields were measured on platinum conversion targets of various thicknesses and at various electron energies. The apparatus used in the measurement is described and shown graphically. The results are shown graphically for a 1-Mev energy band in the solid angle 5.4×10^{-3} steradians. They show that the yield is, in general, optimum for a converter thickness of the order of a radiation length. The graphs permit the optimum thickness of the converter to be determined as a function of the predetermined needs. An appendix discusses the resolution $R = \Delta E/E$. (J.S.R.)

2590 (TID-19667) RESONANCE POLES NEAR AN INELASTIC TWO-PARTICLE THRESHOLD. M. Nauenberg and J. C. Nearing (Columbia Univ., New York). [1963]. Contract [AT(30-3)-187]. 6p.

A simple, extended Lee model is used to show that the pole associated with the Y_1^* resonance when it is above the threshold does not become the pole associated with the resonance when it moves below threshold. Instead, there are always two poles, one on each Riemann sheet, which move continuously without changing sheets near the inelastic threshold. The resonance is determined by the pole on the Riemann sheet closest to the physical sheet at the resonance energy. The mixing of symmetry representations in the resonance state is also considered. (D.C.W.)

2591 (TID-19682) THE ELECTROMAGNETIC FORM FACTOR OF THE NEUTRINOS. J. Bernstein (New York Univ., New York) and T. D. Lee (Columbia Univ., New York). [1963]. Contracts [AT(30-1)-187] and [AT(30-1)-1480]. 16p.

The form factors are calculated by considering the sum of all Feynman graphs that are of arbitrary order in the fine structure constant, but only first order in g^2. The graphs are rendered finite by introducing a cutoff Λ in momentum space. The limit $\Lambda \to \infty$ is taken only after summation of all the graphs. A zero-mass, two-component theory for the neutrino and the existence of an intermediate boson are assumed. (D.C.W.)

2592 (TID-19706) GENERALIZED SHMUSHKEVICH METHOD; PROOF OF BASIC RESULTS. A. J. Macfarlane, N. Mukunda, and E. C. G. Sudarshan (Rochester, N. Y. Univ.). Oct. 24, 1963. Contract AT(30-1)-875. 24p.

Certain orthogonality properties of the Clebsch-Gordon (CG) coefficients of an arbitrary compact group G are derived. The fact that the irreducible representations (IR's) of G need not be equivalent to their complex conjugates and that the same IR can appear more than once in the reduction of the direct product of two IR's of G is considered. The properties obtained allow the development of a generalized Shmushkevich method for directly writing down consequences of the invariance of particle interactions under G. (auth)

2593 (TID-19707) UNIVERSAL THEORY OF SEMI-WEAK INTERACTIONS. R. E. Marshak, C. Ryan (Rochester, N. Y. Univ.); T. K. Radha (Stanford Univ., Calif. Inst. of Theoretical Physics); and K. Raman (Institute for Mathematical Sciences, Madras). Oct. 21, 1963. Contract AT(30-1)-875. 42p.

A universal theory of semi-weak interactions is proposed on the basis of a new baryon–lepton symmetry principle and the conservation of a new quantum number x, the "weak hypercharge." The universality of the theory is achieved by coupling two intermediate charged vector bosons of different mass and x to the strangeness-conserving and strangeness-changing currents. Acceptance of the conserved vector current hypothesis for strangeness-conserving processes leads to definite statements concerning the fields describing the electron and muon neutrinos, the $(\Delta Q/\Delta S)$ properties of the strangeness-changing current and the existence of neutrino flip. The more striking experimental predictions of the theory (neutrino flip accompanied by hyperon production) are discussed in some detail. Alternative formulations of the theory are examined, and it is shown that very little flexibility is allowed within the framework of a dynamical baryon–lepton symmetry principle. (auth)

2594 (UCRL-10235) $\Lambda\pi^+\pi^-$ FINAL STATE IN K^--p INTERACTIONS AT K^- MOMENTA OF 1.22 AND 1.51 Gev/c. Janice Button-Shafer, Darrell Huwe, and Joseph J. Murray (California. Univ., Berkeley). June 6, 1962. Contract W-7405-Eng-48. 19p. (CONF-295-5)

From International Conference on High Energy Physics, Geneva, July 1962.

The analysis of the events is described; and the mass distributions and Y^* decay and production angular distributions, as well as the fits obtained for them, are presented and discussed. Cross sections of 2.2 ± 0.2 and 1.4 ± 0.3 mb were obtained at 1.22 and 1.51 Bev/c, respectively. (D.C.W.)

2595 (UCRL-10291) $K-\pi$ MASS DISTRIBUTIONS FOR $\pi^- + p \to Y + K + \pi$ AT INCIDENT MOMENTA OF 1.89 THROUGH 2.24 Gev/c. Gideon Alexander, George R. Kalbfleisch, Donald H. Miller, and Gerald A. Smith. California. Univ., Berkeley. Lawrence Radiation Lab.). June 14, 1962. Contract W-7405-eng-48. 7p. (CONF-295-3)

From International Conference on High Energy Physics, Geneva, July 4-11, 1962.

The data obtained at 1.89, 1.95, 2.04, 2.16, and 2.24 Bev/c were separated into two groups (1.89–2.04 and 2.16–2.24 Bev/c) on the basis of distribution similarities. In the lower momenta data, a very sharp peak with an estimated width of ≤20 Mev appeared at mass 730 Mev. No such enhancement was observed at the higher momenta. The $K_{\frac{1}{2}}^*$ (885 Mev) resonance was produced strongly at all energies; its width is 60 ± 5 Mev. An isotopic spin $I = \frac{1}{2}$ still seems likely for the K^* (730 Mev) resonance. (D.C.W.)

2596 THE SEPARATION OF PERIPHERAL AND CENTRAL COLLISIONS IN HIGH ENERGY INTERACTIONS. H. W. Meier (Forschungsstelle für Physik hoher Energien der Deutschen Akademie der Wissenschaften zu Berlin, Zeuthen, Ger.). Ann. Physik (7), 11: 394-404 (1963). (In German)

A method for the separation of the central and peripheral collisions in high-energy interactions was investigated. The separation terminates in a separation of the events in which the angular distribution of the π mesons produced is isotropic in the π-nucleon center of mass system. As a parameter for differentiation of the peripheral and central collisions, the Lorentz factor of the center-of-mass system of the charged π mesons is used. The method was applied to the $\pi-$nucleon interaction at 7.5 Bev/c. With this method it is possible to consider separately the angular and pulse distribution of the secondary particles for peripheral and central collisions. The central collisions can be explained by means of the statistical theory. Isobar formation is present in peripheral collisions. (tr-auth)

2597 CALCULATION OF THE γ-COMPONENT OF HEAT GENERATION. L. P. Bokacheva, V. P. Kiselev-Fedorov, K. K. Popkov, and S. M. Rubanov. Inzh. Fiz. Zh., Akad. Nauk Belorussk. SSR, 6: No. 9, 47-51(Sept. 1963). (In Russian)

A new method for simplification of the calculations of heat generation caused by interaction between γ radiation and a substance in thermal protective shields in the reactor vessel is proposed. The simplification involves the replacement of water layers by iron ones on the basis of the adopted assumptions when describing the interaction between γ radiation and a substance. The functions, defining heat generation in iron depending on iron beds and the water column, are presented. (auth)

2598 INVARIANT IMBEDDING AND TIME-DEPENDENT DIFFUSE REFLECTION OF A PENCIL OF RADIATION BY A FINITE INHOMOGENEOUS FLAT LAYER. PART I. Richard Bellman, Robert Kalaba, and Sueo Ueno (Rand Corp., Santa Monica, Calif.). J. Math. Anal. Appl., 7: 310-21(Oct. 1963).

The principle of invariant imbedding is used to obtain integral equations for the scattering function of a pencil of radiation by a finite, plane-parallel, inhomogeneous, non-emitting, and isotropically scattering atmosphere with mono-directional illumination of the lower surface, allowing for the incident Dirac delta-function and unit step-function, time-dependent, net fluxes. Finally, the Laplace transform of the integral equation for the s-function is derived. (auth)

2599 STATIC THREE-BODY NUCLEAR FORCES. Frances M. Coury and William M. Frank (Naval Ordnance Lab., Silver Spring, Md.). Nucl. Phys., 46: 257-74(July 1963).

A Chew-Low formalism is constructed for the system of three fixed nucleons interacting with symmetric pseudoscalar mesons. The three-body force between fixed nucleons resulting from the exchange of two pions is calculated and agrees with the result of Fujita and Miyazawa. The off-diagonal matrix elements of the potential are calculated. These are important to the description of the structure of the three-body system. (auth)

2600 RESTRICTIONS ON REGGE POLE TRAJECTORIES. I. S. Shapiro (Inst. of Theoretical and Experimental Phys., Moscow). Nucl. Phys., 48: 58-64(Sept. 1963).

Under the assumption of the univalence of the trajectory of the main vacuum pole in the plane of the complex variable t (square of the 4-momentum transfer) inequalities restricting this trajectory in the physical region of t are obtained. (auth)

2601 INVARIANT QUANTITIES IN SEMI-SIMPLE GROUPS. [PART] I. M. Umezawa (Institut de Recherches Nucléaires, Strasbourg). Nucl. Phys., 48: 111-20(Sept. 1963).

The Gell-Mann method for constructing the invariant quantities in the SU_3 group is developed further and is applied to the unitary unimodular groups of any dimension. The relation between the invariant quantities obtained by this method and the invariant quantities introduced by Killing, Cartan, and Racah in their purely algebraic research is discussed. (auth)

2602 MONTE CARLO CALCULATIONS ON THE REFLECTION AND TRANSMISSION OF SCATTERED GAMMA RAYS. Dominic J. Raso (Technical Operations Research, Burlington, Mass.). Nucl. Sci. Eng., 17: 411-18(Nov. 1963).

Monte Carlo calculations were performed to determine the backscattering from and transmission through concrete of 0.2, 0.5, 1.0, 2.0, 4.0, 6.0, and 10.0 Mev gamma rays. The radiation was assumed to be incident on a semi-infinite medium and on slab thicknesses of 0.5, 1.0, 2.0, and 4.0 mfp at angles of cos θ_0 = 1.0, 0.75, 0.50, 0.25, and 0.10. The case histories of 5000 photons were followed on the IBM 704 digital computer for each of the 175 geometries (874,000 histories). The information obtained included: the characteristics of emergent photons, which were stored on magnetic tape; a routine that processes the characteristics to give polar and azimuthal angular dose distribution; and detailed results from the application of the processing routine to the parameters investigated. (auth)

2603 A LOWER BOUND FOR ELASTIC CROSS-SECTIONS IN THE HIGH-ENERGY REGION. A. Martin (CERN, Geneva). Nuovo Cimento (10), 29: 993-6(Sept. 1, 1963).

From the assumption of the validity of the Mandelstam representation it is shown that the effective elastic total cross section in the limit of very high energies is directly proportional to the square of the effective total cross section and inversely proportional to the square of the log of the energy. (C.E.S.)

2604 ROTATION MATRICES CORRESPONDING TO COMPLEX ANGULAR MOMENTA. E. G. Beltrametti and G. Luzzatto (Università, Genoa and Istituto Nazionale di Nucleare, Genoa). Nuovo Cimento (10), 29: 1003-18 (Sept. 1, 1963).

An attempt is made to extend to complex values of the angular momentum the idea of a representation of the rotation group R_3. Using the homeomorphism between the unitary unimodular group U_2 and R_3, a set of infinite matrices is built, each one singular at one pole of the sphere; they give back the usual rotation matrices for integer or half-integer values of the angular momentum. The product rules of these matrices are discussed, and the resulting structure is analyzed: it retains some but not all the properties of a group representation. (auth)

2605 SEPARABLE NONLOCAL POTENTIALS AND REGGE POLES. M. McMillan (Cambridge Univ., Eng.). Nuovo Cimento (10), 29: 1043-50(Sept. 1, 1963).

Partial wave amplitudes and Regge poles for nonrelativistic two-body scattering via a separable nonlocal potential are studied. The Schrödinger equation is solved exactly and the partial wave amplitudes are written in a simple closed form valid for any potential satisfying certain minor restrictions at the origin and at infinity. Many previously known properties of amplitudes and Regge poles appear rather simply here. (auth)

2606 EXACT FORM FOR SCATTERING AMPLITUDE IN REGGE POLE THEORY. A. L. Read (Brookhaven National Lab., Upton, N. Y.); J. Orear, and H. A. Bethe. Nuovo Cimento (10), 29: 1051-8(Sept. 1, 1963). (BNL-6868)

The exact form for the contribution of a single Regge pole is given both for positive and negative angular momentum without making the usual approximations. This exact form involves Legendre functions of the first and second kind with nonintegral index and argument greater than one. These functions are plotted. A one-parameter fit is made to the high-energy p-p elastic scattering data that give good agreement with experiment. (auth)

2607 A SYMMETRY SCHEME FOR ELEMENTARY PARTICLES. H. Harari (Israel Atomic Energy Commission, Rehovoth). Nuovo Cimento (10), 29: 1068-79 (Sept. 1, 1963). (IA-828)

The group $Sp_2 \otimes SU_2$ is suggested as a possible underlying symmetry for the strong and weak interactions. The representations of the group are divided into four classes and the elementary particles are classified according to the different classes and representations. The eight baryons are in one supermultiplet but the eight mesons are divided into two sets, thus minimizing the mass difference between particles of the same representation. Other particles including the resonances and the leptons are fitted into the proposed scheme. (auth)

2608 REGGE TRAJECTORIES FOR A CLASS OF WEAK SHORT-RANGE POTENTIALS. D. Flamm (CERN, Geneva). Nuovo Cimento (10), 29: 1080-8(Sept. 1, 1963).

The movement of the poles in the S matrix for non-relativistic scattering by a potential of the form $U(r) = \alpha\mu^{1-\beta}\exp[-\mu r]/r^{1+\beta}$ with small coupling constant is investigated to first order in α. It is found that for $\beta \neq 0$ a second kind of trajectory appears that is not present for the Yukawa potential. For $|K|^2 \ll \mu^2$ the picture of trajectories shows periodicity with respect to β. (auth)

2609 GAUGE INVARIANCE, THE VERTEX FUNCTION, AND THE MAGNITUDE OF THE RENORMALIZATION CONSTANTS OF QUANTUM ELECTRODYNAMICS. O. Fleischman (New York Univ., New York). Nuovo Cimento (10), 29: 1098-1119(Sept. 1, 1963).

By means of the Gupta-Bleuler formalism for quantum electrodynamics, it is proved that the regularized second-order vertex function, in the limit of high momentum-transfer P^2, on the mass shell, is given by $\gamma_\mu C \log P^2$ rather than γ_μ. This proves that the assumption of G. Källén that the renormalized vertex function tends to $Z_1\gamma_\mu$ in the above limit, is not valid to second order in the Feynman gauge. Since the Källén formalism is the proper renormalization of the Feynman gauge, this indicates that Källén's assumption is not valid in the Källén gauge. The failure of this assumption would invalidate Källén's proof that a completely finite theory of quantum electrodynamics cannot be formulated in a consistent way. A valid operator gauge-transformation that reproduces the Landau transformations for the propagators was formulated. The operator gauge-transformation introduces a set of noninteracting scalar fields in a Hilbert space that has an indefinite metric. In theories that do not have a Ward identity, the high-momentum limit of the renormalized vertex function was sometimes taken as the definition of Z_1. It is shown that this is not correct for the vector meson, but that it may be valid for the pseudoscalar meson, when these mesons interact with a spinor field. (auth)

2610 CLASSICAL RELATIVISTIC DYNAMICS OF "SPIN" PARTICLES. D. Lovelock (Univ. of Bristol, Eng.). Nuovo Cimento (10), 29: 1126-42(Sept. 1, 1963).

By means of a variational principle together with a principle of total angular momentum, the general equations of motion of a particle with internal spin are deduced. This procedure gives rise to a differential equation that the components of the spin angular momentum tensor must satisfy. The general solution of this differential equation permits a classification of most previous theories that profess to provide a basis for this type of motion. (auth)

2611 CLASSICAL THEORY OF THE SCATTERING OF MESONS BY FREE NUCLEONS RESULTING IN SCATTERED PARTICLES HAVING TWICE THE INCIDENT ENERGY. EXAMPLE OF NEUTRAL SCALAR FIELD. Vachaspati (Univ. of Lucknow, India). Nuovo Cimento (10), 29: 1143-61(Sept. 1, 1963).

It is shown by the example of a neutral scalar field that the scattering of a plane monochromatic beam of mesons by a free nucleon can lead to scattered particles having energies that are integral multiples of the energy of the incident particles. Explicit calculations for scattering into particles of twice the original energy are made and the cross section is shown to be proportional directly to the intensity and inversely to the energy of the incident particle beam. The significance of the effect and its quantum analogue are discussed. (auth)

2612 PION-DEUTERON SCATTERING AT 330 Mev. G. Brunhart, G. S. Faughn, and V. P. Kenney (Univ. of Kentucky, Lexington). Nuovo Cimento (10), 29: 1162-8 (Sept. 1, 1963).

Pion-deuteron scattering at 330 Mev was studied in a hydrogen bubble chamber. The total cross section was measured to be (55.5 ± 2.97) mb, of which (13.3 ± 1.17) mb is charged elastic, (33.9 ± 2.60) mb is charged inelastic, and (8.3 ± 0.85) mb is scattering into an all-neutral final state. The differential cross section for elastic scattering is appreciably smaller than values obtained by straightforward application of the impulse approximation, suggesting that higher-order multiple scattering effects are important at this energy. (auth)

2613 RELATIVISTICALLY INVARIANT PARTIAL-WAVE ANALYSIS. H. Munczek (Facultad de Ciencias Exactas y Naturales, Buenos Aires). Nuovo Cimento (10), 29: 1175-85(Sept. 1, 1963).

A general method is given that allows to perform the partial-wave analysis of an arbitrary reaction, and simultaneously exhibits relativistic invariance. It is formally well adapted to use in connection with dispersion relations. The examples of two scalar particles of elastic scattering and of pion-nucleon elastic scattering are worked out. (auth)

2614 RESONANCE MODEL FOR PHOTOPRODUCTION OF η-PARTICLES. K. Nishimura (Universitá, Rome). Nuovo Cimento (10), 29: 1186-94(Sept. 1, 1963).

An approximate dispersion relation of the Cini-Fubini type is used for the photoproduction amplitude of η-particles on protons. In the unitarity condition only the single particle and the resonant states are kept as intermediate states. The resonances considered are ρ, ω, N**, and N***. In the multipole expansion of the amplitudes for the processes leading to these resonances only the lowest-order terms compatible with various conservation laws are retained and the Breit-Wigner formula is assumed for them. The differential cross section and the polarization of the recoil protons are thus expressed as a function of various partial widths that serve as parameters. No numerical calculation is made. (auth)

2615 THE PHOTOPRODUCTION OF NEUTRAL PIONS FROM HYDROGEN IN THE FORWARD DIRECTION, FOR PHOTON ENERGIES BETWEEN 550 Mev AND 1050 Mev. G. Bellettini (Università, Pisa, Italy and Istituto Nazionale di Fisica Nucleare, Pisa, Italy), C. Bemporad, P. L. Braccini, L. Foà, and E. H. Bellamy. Nuovo Cimento (10), 29: 1195-9(Sept. 1, 1963).

Preliminary results for the reaction $\gamma + p \rightarrow \pi^0 + p$ in the neighborhood of the second resonance are presented. The position of the second resonance peak is around 750 Mev. A proton background of undetermined origin was observed, and the angular distributions of the ghost protons are given. (C.E.S.)

2616 CENTRAL AND PERIPHERAL COLLISIONS IN π^--NUCLEON INELASTIC EVENTS AT 16.2 Gev/c. A. Gainotti, C. Lamborizio, and S. Mora (Universitá, Parma, Italy and Istituto Nazionale di Fisica Nucleare, Parma, Italy). Nuovo Cimento (10), 29: 1209-14(Sept. 16, 1963).

Meson (π^-)-nucleon inelastic collisions at 16.2 Bev/c were considered in order to obtain a separation between central and peripheral collisions. The log γ_c distribution is analyzed and an estimation of the inelasticity coefficient is made for the peripheral collisions. (auth)

2617 ANNIHILATION IN FLIGHT OF 800 Mev POSITRONS. P. L. Braccini, I. X. Ion, A. Stefanini, G. Torelli, and R. Torelli Tosi (Università, Pisa, Italy and Istituto Nazionale di Fisica Nucleare, Pisa, Italy). Nuovo Cimento (10), 29: 1215-22(Sept. 16, 1963).

The total cross section for positron-electron annihilation in flight was measured at incident positron energy of 789 Mev. The measured value is (1.118 ± 0.024) mb, which is in agreement with the Dirac cross section. If the radiative corrections are taken into account this value is two standard deviations too low. (auth)

2618 PARTICLES AND COMPOSITE FIELDS RESULTING FROM INTERACTIONS BETWEEN SEVERAL CURRENTS. B. Jouvet and J. P. Adam (Laboratoire de Physique Atomique et Moléculaire, Paris). Nuovo Cimento (10), 29: 1275-89(Sept. 16, 1963). (In French)

It is shown that when composite bosons result from Fermi couplings between two different pairs of unlike fermions, one can construct an equivalent Yukawa-type theory that postulates at least two boson fields whose renormalization constants are zero. The number of boson fields can be reduced when the Fermi coupling constants fulfil certain relations. To the Fierz group of rearrangement of the fermion pairs, there can be associated a group of Yukawa-type theories that are equivalent, although postulating boson fields of different types. (auth)

2619 THE VECTOR THEORY OF STRONG INTERACTIONS AND ANTINUCLEON-NUCLEON ANNIHILATION. S. M. Berman and R. J. Oakes (Stanford Univ., Calif.). Nuovo Cimento (10), 29: 1329-37(Sept. 16, 1963).

The hypothesis that antinucleon-nucleon annihilation at rest is dominated by single-particle intermediate states consisting of vector mesons is examined. The hypothesis is consistent with current experiments and offers an explanation of certain observed features of the annihilation process. Several critical tests are suggested to verify or repudiate the hypothesis. (auth)

2620 HYPERON-PAIR PRODUCTION. H. D. D. Watson (Imperial Coll. of Science and Tech., London). Nuovo Cimento (10), 29: 1338-45(Sept. 16, 1963).

The production of $Y\bar{Y}$ pairs in $p\bar{p}$ collisions is shown to be consistent with a peripheral model based on K^* exchange, if the $\Sigma\Lambda$ parity is even. The result is not sensitive to the form of the meson-baryon vertices for comparable values of the coupling constants. (auth)

2621 A MODEL OF WEAK INTERACTIONS. H. Ruegg and S. B. Treiman (Princeton Univ., N. J.). Nuovo Cimento (10), 29: 1346-52(Sept. 16, 1963).

A picture of the weak interactions is described in which the $\Delta I = \frac{1}{2}$ and $\Delta I = \frac{3}{2}$ currents responsible for strangeness-changing leptonic reactions are constructed out of direct products of the strangeness-conserving currents responsible for ordinary β decays and a $\Delta S = 1$ isotopic doublet that transforms spatially as a scalar or pseudoscalar, for example, the K-meson field doublet itself. For models that invoke six intermediate bosons, this device introduces a degree of freedom that serves to get around a certain difficulty recently noted. But if the weak current-current interactions are sufficiently local (i.e., if the intermediate bosons are sufficiently heavy), the scheme discussed permits a description that requires only four intermediate bosons. The discussion is based on acceptance of the $\Delta I = \frac{1}{2}$ rule for $\Delta S = 1$ nonleptonic reactions and acceptance of the notion that $\Delta S = 2$ nonleptonic transitions are effectively forbidden. (auth)

2622 A DYNAMICAL MODEL FOR $\omega-\varphi$ MIXING. A. Katz and H. J. Lipkin (Argonne National Lab., Ill. and Weizmann Inst. of Science, Rehovoth, Israel). Phys. Letters, 7: 44-7(Oct. 15, 1963).

For any combination of singlet-octet coupling constants $(\omega_1\rho\pi)$ and $(\omega_8\rho\pi)$, a linear combination of ω_1 and ω_8 whose coupling to $\rho\pi$ is zero can be found. The search for a dynamical reason why the physical φ meson should be just this uncoupled mixture leads to the conjecture that the $\rho\pi$ intermediate state plays a dominant role in the ω_1 and ω_8 self-energies and thus determines the mixing and splitting of φ and ω. (R.E.U.)

2623 CALCULATION OF THE PION NUCLEON MASS RATIO FROM DISPERSION RELATIONS. D. Atkinson (Rutherford Lab., Chilton, Berks, Eng.). Phys. Letters, 7: 65-6(Oct. 15, 1963).

A method is outlined for calculating the phase shifts of the reactions $\pi\pi \rightarrow \pi\pi$ and $\pi n \rightarrow \pi n$. By making general assumptions about the bounded variation of the scattering amplitudes, and by solving the two systems together, values for the various parameters that occur can be deduced, in particular for the nucleon-meson(π) mass ratio. Zero-momentum transfer dispersion relations are used. Some preliminary results on the numerical calculations are given. (R.E.U.)

2624 ASYMPTOTIC PROPERTIES OF THE NEUTRAL K-MESON SCATTERING AMPLITUDE. A. A. Logunov, Nguyen Van Hieu, I. T. Todorov, and O. A. Khrustalev (Joint Inst. for Nuclear Research, Dubna, USSR). Phys. Letters, 7: 71-2(Oct. 15, 1963).

The general postulates of the relativistic local quantum field theory and Phragmen-Lindelof's theorem were used to study the scattering of neutral K-mesons on nucleons. It is shown that if the differential cross section for K-meson scattering and the total cross section approach a constant as $s \rightarrow \infty$, s = (c.m. energy)^2, then the amplitudes for these processes at $t = 0$, $t = -$(c.m. momentum transfer)^2 are purely imaginary and the differential forward scattering cross section is proportional to the total cross section squared. The amplitude of the $K_2^0 \rightarrow K_1^0$-meson transition is given. (R.E.U.)

2625 SMALL-ANGLE ELASTIC SCATTERING OF 24.5 Gev/c PROTONS ON HYDROGEN NUCLEI. P. Breitenlohner (Universitat, Bern), P. Egli, H. Hofer, et al. Phys. Letters, 7: 73-5(Oct. 15, 1963).

Momentum transfer in the 24.5-Bev/c p-p elastic scattering was at 49 and 735 Mev/c. Angular distributions at small angles were studied using a liquid-hydrogen bubble chamber and perpendicularly exposed emulsions. The elastic cross section was found to be 8.8 ± 0.3 mb and the total cross section 39.3 ± 0.8 mb. (R.E.U.)

2626 TOTAL NEUTRON-PROTON INTERACTION CROSS SECTION AT 5.5 Gev. M. N. Khachaturyan and V. S. Pantuyev (Joint Inst. for Nuclear Research, Dubna, USSR). Phys. Letters, 7: 80-1(Oct. 15, 1963).

Polyethylene and carbon targets 48.53 and 42.56 g/cm^2 thick were bombarded with up to 6.5-Bev protons. The energy spectrum of detected neutrons was limited by the proton energy maximum and by the threshold of the discriminator operation. The total cross section for the neutron-proton interaction at 5.5 Bev was found to be (41.2 ± 1.7) mb. (R.E.U.)

2627 UNITARY SYMMETRY IN PHOTOPRODUCTION AND OTHER ELECTROMAGNETIC INTERACTIONS. C. A.

Levinson (Weizmann Inst. of Science, Rehovoth, Israel), H. J. Lipkin, and S. Meshkov. Phys. Letters, 7: 81-4 (Oct. 15, 1963).

It is shown that an SU_2 (U-spin) subgroup of SU_3 is rigorously conserved to all orders in the electromagnetic interactions and in the strong interactions which are SU_3-invariant. The use of U-spin conservation to obtain new experimental predictions is discussed. Predictions following from U-spin conservation such as photoproduction, meson photoproduction, decay of N*, Y*, and Ξ*, static electromagnetic properties for the baryon octet, photoproduction of two mesons, and photoproduction of Z^- are given. (R.E.U.)

2628 MEASUREMENT OF THE TRIPLE SCATTERING PARAMETER R′ IN PROTON-PROTON SCATTERING AT 137½ Mev. Stanley Hee and Richard Wilson (Harvard Univ., Cambridge, Mass.). Phys. Rev., 132: 2236-9 (Dec. 1, 1963).

The proton-proton triple scattering parameter R′ was measured at a laboratory energy of 137.5 Mev over a range of scattering angles θ_2. The following values were obtained: θ_2(laboratory) = 20°50′, 0.562 ± 0.052; 25°26′, 0.472 ± 0.054; 30°8′, 0.375 ± 0.068; 35°16′, 0.238 ± 0.084; 39°55′, 0.251 ± 0.121. The stated errors include a 5% error in R′ which is systematic from angle to angle. This has been combined quadratically with the other errors. (auth)

2629 UNITARY SYMMETRY AND PROTON-ANTIPROTON INTERACTIONS. Allen E. Everett (Tufts Univ., Medford, Mass.). Phys. Rev., 132: 2278-81(Dec. 1, 1963).

An investigation was made of the conclusions which can be drawn from the unitary symmetry theory of strong interactions about the class of reactions $p + \bar{p} \rightarrow A + B$, where A represents a member of the meson or baryon octet, or the baryon resonance decuplet, and $\bar{B}$ is a member of the corresponding antiparticle multiplet. In the case of baryon or meson production, it is found that the only consequences are a set of inequalities on cross sections which are both weak and experimentally inaccessible. In the case of production of tenfold resonances, one equality among cross sections is obtained, which, however, involves the experimentally difficult reaction in which the final state is an $N^{*-}\bar{N}^{*+}$ pair. In addition there are several inequalities. One set of these, namely $\sqrt{\sigma_Z} \geq |\sqrt{\sigma_Y} - 2\sqrt{\sigma_\Xi}|$, $\sqrt{\sigma_Y} \geq |\sqrt{\sigma_Z} - 2\sqrt{\sigma_\Xi}|$, and $\sqrt{\sigma_\Xi} \geq \frac{1}{2}|\sqrt{\sigma_Z} - \sqrt{\sigma_Y}|$ where σ_Y, σ_Ξ, and σ_Z represent the cross sections (differential or total) for the production of $Y_1^{*-}\bar{Y}_1^{*+}$, $\Xi^{*-}\bar{\Xi}^{*+}$, and $Z^-\bar{Z}^+$ pairs, respectively, gives hope of being both relatively restrictive and experimentally feasible. In particular, it gives limits on the production cross section for the as yet undiscovered strangeness minus three $\bar{Z}^-$ particle. These relations are expected to hold to the extent that the incident energy is large enough that the mass splitting within the unitary multiplets can be ignored. (auth)

2630 ABSORPTION OF Σ^- HYPERONS IN PHOTOGRAPHIC EMULSION NUCLEI. B. Andersen (Universitetet, Oslo), O. Skjeggestad, and D. H. Davis. Phys. Rev., 132: 2281-4(Dec. 1, 1963).

New data for 396 Σ^- capture stars are combined with 231 similar events previously reported. The rate of hyperfragment emission from Σ^- stars is $(2.7^{+0.5}_{-0.4})\%$. Both this rate and an estimate of the frequency of cryptofragment formation are compared with the analogous quantities pertinent to K^- absorptions at rest. Evidence is presented that hyperfragments predominantly originate from Σ^- absorptions in the light elements of the emulsion, while cryptofragments are formed following Σ^- absorption in heavy nuclei. (auth)

2631 ANOMALOUS REGENERATION OF K_1^0 MESONS FROM K_2^0 MESONS. L. B. Leipuner (Brookhaven National Lab., Upton, N. Y.), W. Chinowsky, R. Crittenden, R. Adair, B. Musgrave, and F. T. Shively. Phys. Rev., 132: 2285-90 (Dec. 1, 1963). (BNL-6837)

A beam of 1.0-Bev/c K_2^0 mesons passing through liquid hydrogen in a bubble chamber was seen to generate K_1^0 mesons with the momentum and direction of the original beam. The intensity of K_1^0 production was far greater than that anticipated from conventional mechanisms, and the suggestion is made that the K_1^0 mesons are produced by coherent regeneration resulting from a new weak long-range interaction between protons and K mesons. (auth)

2632 FORWARD PION-PION SCATTERING IN THE $\lambda\phi^4$ THEORY. M. Baker and I. J. Muzinich (Univ. of Washington, Seattle). Phys. Rev., 132: 2291-6(Dec. 1, 1963).

An exact expression is obtained for the sum of the bubble diagrams for forward π meson-π meson scattering in the $\lambda\phi^4$ theory, with zero mass internal π mesons. The exact solution of the problem for massless internal π mesons follows naturally from the solution of the Bethe-Salpeter equation, with the bubble-exchange kernel, which is the asymptotic limit of the equation for π mesons with finite mass. (auth)

2633 MESON PRODUCTION IN p + d COLLISIONS AND THE I = 0 π-π INTERACTION. I. MEASURED MOMENTUM SPECTRA OF He^3 AND H^3 NUCLEI FROM HIGH-ENERGY p + d COLLISIONS. Alexander Abashian, Norman E. Booth, Kenneth M. Crowe, Roger E. Hill, and Ernest H. Rogers (Univ. of California, Berkeley). Phys. Rev., 132: 2296-2304(Dec. 1, 1963). (UCRL-10407)

The momentum spectra of He^3 and H^3 nuclei produced in p + d collisions were measured with high resolution. Data were obtained at several angles and incident proton energies of about 745 Mev. Each spectrum exhibits a peak due to single π meson production and a continuum due to double π meson production. An anomalous bump was observed in the He^3 spectra which we interpret as an I = 0 virtual dipion with a scattering length of $2\hbar/\mu c$. The experiment and techniques are described. Four papers are included in this series. (auth)

2634 MESON PRODUCTION IN p + d COLLISIONS AND THE I = 0 π-π INTERACTION. II. STUDY OF THE REACTIONS $p + d \rightarrow He^3 + \pi^0$ AND $p + d \rightarrow H^3 + \pi^+$. Norman E. Booth (Univ. of California, Berkeley). Phys. Rev., 132: 2305-8(Dec. 1, 1963). (UCRL-10408)

Absolute cross sections for the reactions $p + d \rightarrow He^3 + \pi^0$ and $p + d \rightarrow H^3 + \pi^+$ were measured at several angles and energies. The experimental He^3 and H^3 momentum resolution was computed and compared with the results obtained for these two reactions. By comparing experimental data on these reactions with the reaction $p + p \rightarrow d + \pi^+$ it was possible to compute the impulse-approximation integral relating the processes. The results are in good agreement with other experiments. (auth)

2635 MESON PRODUCTION IN p + d COLLISIONS AND THE I = 0 π-π INTERACTION. III. SPIN AND PARITY OF THE I = 0 ANOMALY. Norman E. Booth, Alexander Abashian, and Kenneth M. Crowe (Univ. of California, Berkeley). Phys. Rev., 132: 2309-13(Dec. 1, 1963). (UCRL-10409)

An attempt was made to determine the spin and parity of the I = 0 anomaly by detecting charged pions and gamma rays in coincidence with He^3. The results are consistent with the interpretation that the predominant mode of decay is into two pions with a charged-to-neutral ratio of 2/1, indicating a state of spin 0 and even parity. (auth)

2636 MESON PRODUCTION IN p + d COLLISIONS AND THE I = 0 π-π INTERACTION. IV. DOUBLE-PION PRODUCTION AND PION-PION SCATTERING. Norman E. Booth and Alexander Abashian (Univ. of California, Berkeley). Phys. Rev., 132: 2314-22(Dec. 1, 1963). (UCRL-10410)

An analysis of the measurements on the reaction p + d → He^3 + 2π is presented and it is shown that the anomalous bump in the He^3 spectrum cannot be accounted for by π–He^3 final-state interactions, by Bose statistics for the two pions, or by the deuteron and He^3 wave functions. The anomaly can be satisfactorily explained by a strong final-state interaction between the two pions. The S-wave π-π scattering length in the I = 0 state is determined to be $2\hbar/\mu c$. (auth)

2637 ESTIMATED CROSS SECTION FOR THE REACTION p + p → d + W. James Nearing (Columbia Univ., New York). Phys. Rev., 132: 2323-4(Dec. 1, 1963).

The cross section for the reaction p + p → d + W was recalculated in a relativistic form. The new estimate of the cross section is considerably higher than the one given previously by Bernstein (NSA 17: 13438). (auth)

2638 DILATATIONALLY INVARIANT QUANTUM ELECTRODYNAMICS OF ELECTRONS AND MUONS. R. Haag and Th. A. J. Maris (Univ. of Illinois, Urbana). Phys. Rev., 132: 2325-30(Dec. 1, 1963).

The equation for a lepton propagator is studied in dilatationally invariant quantum electrodynamics and the possibility of an electrodynamic calculation of the electron-muon mass ratio is discussed. (auth)

2639 CLASSICAL THEORY OF THE DIRAC ELECTRON. Zvi Grossmann and Asher Peres (Israel Inst. of Tech., Haifa). Phys. Rev., 132: 2346-9(Dec. 1, 1963).

The Hamiltonian theory of a classical particle displaying all the features of the Dirac electron (spin, Zitterbewegung, etc.) except for the superposition principle is presented. The particle is described by eight internal canonical variables, of which three are the spin angular momentum vector. The five other variables have no simple physical meaning, but are nevertheless necessary for a consistent theory. The equations of motion are not manifestly covariant, and the Lorentz invariance of the theory is proved by constructing the ten generators of the inhomogeneous Lorentz group. (auth)

2640 UNITARY SYMMETRY AND ELECTROMAGNETIC INTERACTIONS. R. J. Oakes (Sanford Univ., Calif.). Phys. Rev., 132: 2349-52(Dec. 1, 1963).

The general form of the electromagnetic interaction in the octet version of the proposed higher symmetry scheme based on the group SU_3 is derived. The result, which is applicable to an arbitrary multiplet, is expressed in an especially simple form by introducing the notion of U-spin. Relations among electromagnetic form factors, mass splittings, decay amplitudes, and scattering amplitudes, previously obtained by various authors in the case of octets, are shown to follow immediately, as well as their generalizations to arbitrary multiplets. Where possible, comparisons are made with experiment. (auth)

2641 THIRD-ORDER COULOMB WAVE FUNCTION AND SINGLE QUANTUM ANNIHILATION. C. O. Carroll and R. F. O'Connell (Univ. of Notre Dame, Ind.). Phys. Rev., 132: 2540-4(Dec. 15, 1963). (TID-19576)

An expression for the third-order Coulomb wave function, correct to order $(\alpha Z)^3$ for all momenta and energies, is derived. Using this wave function the total cross section for single-photon emission resulting from a positron annihilating with a K-shell electron (single quantum annihilation), valid to relative order $(\alpha Z)^2$, is calculated numerically. The results for lead are compared to the exact answer of Jaeger and Hulme, and the results for silver are also given graphically. The effect of the third-order term in the cross section is found to be significant, especially for low and intermediate positron energies. The cross section for lead is found to be qualitatively correct while that for silver is essentially exact. The question of how to treat the normalization factors of the various wave functions is also discussed. (auth)

2642 DISINTEGRATION OF THE DEUTERON IN A COULOMB FIELD. Raymond Gold (Argonne National Lab., Ill.) and Calvin Wong. Phys. Rev., 132: 2586-99(Dec. 15, 1963).

The Coulomb disintegration of the deuteron is treated by means of perturbation theory. The breakup cross section is determined in the electric-dipole approximation. Total cross sections were calculated for deuteron laboratory energies below 25 Mev and for target nuclei in the range $4 \leq Z \leq 92$. The results of these calculations are compared with earlier theoretical estimates and recent experimental measurements. (auth)

2643 INELASTIC SCATTERING OF 18.2-Mev PROTONS BY DEUTERONS. Robert E. Warner (Antioch Coll., Yellow Springs, Ohio). Phys. Rev., 132: 2621-6(Dec. 15, 1963).

Measurements of the inelastic cross section $d^3\sigma/d\Omega_1 d\Omega_2 dE_1$ for breakup of deuterons by 18.2-Mev protons were made by detecting both breakup protons in coincidence. Proton–deuteron breakup events were identified from two-dimensional pulse-height spectra. Typical cross sections ranged from 3 mb/sr^2–Mev at $\theta_1 = -\theta_2 = 15°$ to 0.6 mb/sr^2–Mev at $\theta_1 = -\theta_2 = 60°$. The data are in substantial disagreement with the predictions of two theories based upon the impulse approximation; the zero-range theory of Frank and Gammel, and the spectator model of Kuckes, Wilson, and Cooper. Reasons for the disagreement are discussed. (auth)

2644 ABSOLUTE POSITIVE PION PHOTOPRODUCTION CROSS SECTIONS FROM HYDROGEN. R. J. Walker, T. R. Palfrey, Jr., R. O. Haxby, and B. M. K. Nefkens (Purdue Univ., Lafayette, Ind.). Phys. Rev., 132: 2656-63 (Dec. 15, 1963).

Absolute differential cross sections for the photoproduction of mesons (π^+) of 33.8-Mev laboratory kinetic energy from protons were measured at eight angles between 29.5 and 146.1° in the center-of-mass system. The overall absolute accuracy is 4%, while the relative accuracy within the angular distribution is 3%. Comparison is made to various theoretical calculations, with and without inclusion of the effect of a γ-π-ρ-meson coupling. Existing calculations based on dispersion theory give only fair agreement with the data. (auth)

2645 MUON CAPTURE IN NEON. J. L. Rosen, E. W. Anderson, E. J. Bleser, L. M. Lederman, S. L. Meyer, J. E. Rothberg, and I-T. Wang (Columbia Univ., New York). Phys. Rev., 132: 2691-2(Dec. 15, 1963).

By exploiting the transfer process (μ^-p) + Ne → p + (μ^-Ne), the disappearance rate of negative muons bound to neon nuclei was measured to be $\lambda = (0.658 \pm 0.010) \times 10^6$ sec^{-1}. (auth)

2646 PROTON-PROTON BREMSSTRAHLUNG AND THE OFF-ENERGY-SHELL BEHAVIOR OF THE p-p INTERACTION. M. I. Sobel (Harvard Univ., Cambridge, Mass.) and A. H. Cromer. Phys. Rev., 132: 2698-2702 (Dec. 15, 1963).

The cross section for proton-proton bremsstrahlung at

160-Mev incident energy is calculated using the Yale and the Brueckner–Gammel–Thaler phenomenological nucleon-nucleon potentials. The cross section depends strongly on the off-energy-shell behavior of the T matrix for these potentials. Results for these two potentials differ by a factor of two to three, indicating that bremsstrahlung experiments should be able to distinguish between them. (auth)

2647 HIGH-ENERGY BEHAVIOR OF TOTAL CROSS SECTIONS. Yoichiro Nambu (Univ. of Chicago) and Masao Sugawara. Phys. Rev., 132: 2724-7(Dec. 15, 1963).

A proof of Pomeranchuk's theorem regarding the high-energy limits of the total cross sections is presented. The proof consists of assuming the usual analyticity for the forward elastic amplitudes and the assumption that these amplitudes become pure by imaginary in the high-energy limit. This proof does not require that the total cross sections have finite limits. It is also shown that the total cross-section $\sigma(s)$ as a function of s, the total c.m. energy squared, behaves asymptotically as $\sigma(s) = \sigma(\infty) + \delta/s^{1/2} + O(1/s)$ when $\delta(\infty)$ is nonzero, where δ is some constant. This asymptotic form is based upon a more specific assumption that high-energy elastic scattering is described by an effective complex and energy-dependent potential which satisfies a dispersion relation in the energy variable. However, the above asymptotic form is valid independently of the dependence of this effective potential on the spacial coordinate. It is argued that the term $\delta/s^{1/2}$ in the above asymptotic form should be regarded as genuinely asymptotic, while the term of the order of $1/s$ is not. According to this criterion, the available high-energy p–p data are not so close to the asymptotic region as the $\pi^{\pm}$–p data in the same laboratory momentum range. (auth)

2648 TWO-PION-EXCHANGE CONTRIBUTION TO THE THREE-BODY Λ-NUCLEON INTERACTION. J. D. Chalk, III and B. W. Downs (Univ. of Colorado, Boulder). Phys. Rev., 132: 2727-34(Dec. 15, 1963).

The two-pion-exchange contribution to the three-body Λ-nucleon interaction is derived from a static model and also from covariant perturbation theory. It is found that the local part of the potential calculated by the latter method is similar to that part of the static-model potential which corresponds to the formation of lambda-antisigma pairs in intermediate states. This potential is noncentral and has the form $(\tau^1 \cdot \tau^2)(\sigma^1 \cdot r_1)(\sigma^2 \cdot r_2) f(r_1, r_2)$, where σ^i and τ^i are the spin and isotopic-spin operators for the two nucleons, and r_1 and r_2 are the Λ-nucleon separation vectors. An estimate is made of the importance of this potential in the binding of the hypertriton by calculating its expectation value with respect to hypertriton wave functions corresponding to two-body interactions with hard cores. In these calculations, the three-body potential is found to contribute less than 5% of the expectation value of the total Λ-nucleon interaction. (auth)

2649 π^-/π^+ RATIO FOR PHOTOPRODUCTION FROM DEUTERIUM. J. Pine and M. Bazin (Stanford Univ., Calif.). Phys. Rev., 132: 2735-40(Dec. 15, 1963).

The ratio of the π^- and π^+ photoproduction cross sections from deuterium was measured for 12 combinations of π-meson angle and momentum. In terms of the kinematics for $\gamma + p \rightarrow \pi^+ + n$, the experiment covers photon energies from 165 to 200 Mev and center-of-mass angles from 40 to 145°. The results are corrected to obtain the π^-/π^+ ratio for free nucleons, and, from comparison with theory, the γ-π-ρ coupling constant is estimated to be $+0.1 \pm 0.3$. (auth)

2650 BOOTSTRAP MODEL OF NONDEGENERATE VECTOR-MESON OCTET. Richard H. Capps (Università, Rome and Northwestern Univ., Evanston, Ill.). Phys. Rev., 132: 2749-55(Dec. 15, 1963).

The bootstrap model of the V (vector) meson octet, in which these particles produce themselves as resonances in the P wave two-particle states of the PS (pseudoscalar) meson octet, is generalized to include the effect of mass splitting. The three V-meson masses and five V-PS-PS interaction constants are considered as functions of the three PS-meson masses. Only terms linear in the deviations from degeneracy are included in the dispersion relations. The physically observed PS-meson masses lead to a calculated ρ/K^* mass ratio significantly smaller than one, while the calculated ratio of the mass of the isoscalar V meson to that of the K^* is either somewhat larger than or approximately equal to one. The mass splittings lead to deviations in the ratios of the interaction constants from the values corresponding to unitary symmetry, but the deviations are small enough so that unitary symmetry is satisfied approximately. The calculated $\rho\pi\pi$ and $K^*\pi K$ interaction constants are about 2 or $2\frac{1}{2}$ times larger than the experimental values. (auth)

2651 PRODUCTION OF MULTIMESON RESONANCES BY π^+p INTERACTION AND EVIDENCE FOR A $\pi\omega$ RESONANCE. Maris Abolins, Richard L. Lander, Werner A. W. Mehlhop, Nguyen-huu Xuong, and Philip M. Yager (Univ. of California, La Jolla). Phys. Rev. Letters, 11: 381-5 (Oct. 15, 1963).

Measurements are presented for the partial cross sections of the reaction $\pi^+ + p \rightarrow \pi^+ + p + X$ at 3.43 and 3.54 Bev/c, where X represents the multimeson resonances ω, η, ρ^0, f^0, and ϕ. Evidence is presented for a $\pi\omega$ resonance at 1.22 Bev with a full width of 0.100 ± 0.020 Bev. (C.E.S.)

2652 INTERMEDIATE BOSONS: PAIR PRODUCTION CROSS SECTION BY PHOTONS. Alfred C. T. Wu (Massachusetts Inst. of Tech., Cambridge and Univ. of Michigan, Ann Arbor), Tai Tsun Wu, and Kurt Fuchel. Phys. Rev. Letters, 11: 390-4(Oct. 15, 1963).

The total photoproduction cross section for intermediate boson pairs is calculated for various values of the boson mass and anomalous magnetic moment. Photoproduction on protons and iron is considered. (C.E.S.)

2653 EFFECT OF HIGHER ORDER WEAK INTERACTIONS ON THE PRODUCTION CROSS SECTION OF INTERMEDIATE BOSONS BY NEUTRINOS. Tai Tsun Wu (Inst. for Advanced Study, Princeton, N. J.). Phys. Rev. Letters, 11: 395-6(Oct. 15, 1963).

The meson(μ) decay and the leptonic decay modes of the intermediate boson are investigated and are found to have a rate-modifying factor. It is shown that this same factor is present in the production cross section of the intermediate boson by neutrinos in the Coulomb field of a proton or a nucleus. (C.E.S.)

2654 NEW BARYON-LEPTON SYMMETRY PRINCIPLE FOR LEPTONIC WEAK INTERACTIONS. R. E. Marshak (Univ. of Rochester, N. Y.), C. Ryan, T. K. Radha, and K. Raman. Phys. Rev. Letters, 11: 396-9(Oct. 15, 1963).

It is shown that the existence of two distinct neutrinos and the superiority of the octet model of strong interactions over the Sakata model leads to a new scheme of baryon-lepton symmetry for leptonic weak interactions that is consistent with experiment. (C.E.S.)

2655 SMALL-ANGLE ELASTIC SCATTERING OF PROTONS AND PIONS, 7-20 Bev/c. K. J. Foley, S. J. Lindenbaum, W. A. Love, S. Ozaki, J. J. Russell, and L. C. L. Yuan (Brookhaven National Lab., Upton, N. Y.). Phys. Rev. Letters, 11: 425-9(Nov. 1, 1963).

Elastic differential cross sections for proton interactions with mesons (π^+) and (π^-) and protons in the momentum region 7-20 Bev/c were reported. The square of the four-momentum transfer was ~0.02–0.6 (Bev/c)^2. Values of the total elastic cross sections were also obtained. Evidence was found for a real amplitude or a sizeable spin dependence in the p + p case and for a real amplitude for π^+ + p. (C.E.S.)

2656 DOUBLE-HYPERFRAGMENT EVENT PRODUCED BY K^- INTERACTION AT 2.3 Bev/c IN NUCLEAR EMULSION. P. H. Steinberg and R. J. Prem (Univ. of Maryland, College Park). Phys. Rev. Letters, 11: 429-31 (Nov. 1, 1963).

An event is shown that consists of two hyperfragments and a meson (K^+) coming from a single interaction star found in a nuclear emulsion stack exposed to a meson (K^-) beam at 2.3 and 2.5 Bev/c. Unique identification of the hyperfragments is impossible, but the binding energy favors ΛH^4 or ΛHe^4. The nature of the production mechanism cannot be determined on the basis of the information available in this single event. (C.E.S.)

2657 DETERMINATION OF THE DEUTERON D WAVE FROM COHERENT π^0 PHOTOPRODUCTION. E. F. Erickson and C. Schaerf (Stanford Univ., Calif.). Phys. Rev. Letters, 11: 432(Nov. 1, 1963).

The differential cross section for the elastic photoproduction of mesons (π^0) in deuterium was measured for an incident gamma energy of 500 Mev to determine the deuteron D wave function. It is found that the D wave in the deuteron ground state is (7.5 ± 0.6)%. (C.E.S.)

2658 POLARIZATION OF Λ HYPERONS FROM PHOTOPRODUCTION IN HYDROGEN. H. Thom, E. Gabathuler, D. Jones, B. D. McDaniel, and W. M. Woodward (Cornell Univ., Ithaca, N. Y.). Phys. Rev. Letters, 11: 433-5(Nov. 1, 1963).

Polarization of the hyperon (Λ) perpendicular to the production plane was measured for the reaction $\gamma + p \rightarrow K^+ + \Lambda$. Measurements at approximately 90° in the center-of-mass system were made for five photon energies ranging from 1000 to 1120 Mev. (C.E.S.)

2659 LIFETIME OF THE ω MESON. N. Gelfand (Columbia Univ., New York), D. Miller, M. Nussbaum, J. Ratau, J. Schultz, J. Steinberger, T.-H. Tan, L. Kirsch, and R. Plano. Phys. Rev. Letters, 11: 436-8(Nov. 1, 1963).

An antiproton beam was introduced into a hydrogen bubble chamber to investigate the reaction $\bar{p} + p \rightarrow K^+ + K^- + \omega$. The meson (ω) was found to have a mass of 784.0 ± 0.9 Mev, a width of 9.5 ± 2.1 Mev, and a lifetime of (0.69 ± 0.15) × 10^{-22} sec. (C.E.S.)

2660 WIDTH OF THE φ MESON. N. Gelfand (Columbia Univ., New York), D. Miller, M. Nussbaum, J. Ratau, J. Schultz, J. Steinberger, T. H. Tan, L. Kirsch, and R. Plano. Phys. Rev. Letters, 11: 438-9(Nov. 1, 1963).

The reaction $\bar{p} + p \rightarrow K^+ + K^- + \pi^+ + \pi^-$ was investigated by means of an antiproton beam in a hydrogen bubble chamber. The meson (φ), which is a $K\bar{K}$ resonance, was observed. The width and mass were determined to be 3.1 ± 1.0 and 1018.6 ± 0.5 Mev, respectively. (C.E.S.)

2661 REGGE-POLE HYPOTHESIS AND π-p DIFFRACTION EXPERIMENTS. Akbar Ahmadzadeh and Ismail A. Sakmar (Univ. of California, Berkeley). Phys. Rev. Letters, 11: 439-41(Nov. 1, 1963). (UCRL-10921)

It is shown that existing π-p scattering data at 5–20 Bev is entirely consistent with a simple Regge-pole representation. A two-parameter fit to the elastic π-p scattering is presented. (C.E.S.)

2662 ROLE OF ρ IN HIGH-ENERGY n-p CHARGE EXCHANGE. R. J. N. Phillips (Atomic Energy Research Establishment, Harwell, Berks, Eng.). Phys. Rev. Letters, 11: 442-3(Nov. 1, 1963).

The previously proposed explanation that the narrow forward peak in n-p charge-exchange scattering at 2.04 and 2.85 Bev may be fitted by a single dominant Regge pole associated with the meson (ρ) is investigated. It is found that the previously proposed model does not fit all of the data satisfactorily and that this model or any modified form in which the meson (ρ) trajectory plays a major role requires the residue function to change sign between t = 0 and $t = m_\rho^2$, where t is the momentum transfer squared and m_ρ is the meson (ρ) mass. (C.E.S.)

2663 BACKWARD PEAK IN HIGH-ENERGY n-p ELASTIC SCATTERING. M. M. Islam and T. W. Preist (Brown Univ., Providence). Phys. Rev. Letters, 11: 444-6(Nov. 1, 1963).

The sharp backward peak in n-p scattering at 2.04 and 2.85 Bev is investigated. Both meson (π) and (ρ) exchange in the u and t channel are considered. The amplitudes due to these exchanges are calculated by means of second-order perturbation theory. Form factors are introduced in the amplitudes. The electric coupling constant of the meson (ρ) with a nucleon is also considered. (C.E.S.)

2664 SU(4) ASSIGNMENTS FOR THE VECTOR RESONANCES. Pekka Tarjanne and Vigdor L. Teplitz (Univ. of California, Berkeley). Phys. Rev. Letters, 11: 447-8 (Nov. 1, 1963). (UCRL-11000)

An interpretation of the meson (κ), which is a 730-Mev Kπ resonance, is proposed. A scheme, based on the 1^- spin and parity assignment for the meson (κ), in which all the vector resonances are interpreted as forming one multiplet corresponding to the adjoint representation of SU(4) is considered. (C.E.S.)

2665 THREE-PION AND FOUR-PION DECAYS OF THE INTERMEDIATE BOSON. G. Feinberg and H. S. Mani (Columbia Univ., New York). Phys. Rev. Letters, 11: 448-50(Nov. 1, 1963).

The three-pion and four-pion decay modes of the intermediate boson (W) are considered on the assumption that they are dominated by $W \rightarrow \rho + \pi$ and $W \rightarrow \omega + \pi$, respectively. The branching ratios between these modes and $W \rightarrow e + \nu$ are tabulated. (C.E.S.)

2666 PARITY OF THE $Y_1^*(1660)$ RESONANCE. M. Taher-Zadeh, D. J. Prowse, P. E. Schelin, W. E. Slater, D. H. Stork, and H. K. Ticho (Univ. of Calif., Los Angeles). Phys. Rev. Letters, 11: 470-4(Nov. 15, 1963).

The reaction $K^- + d \rightarrow p + \Lambda + \pi^-$ was investigated in a deuterium bubble chamber at momenta of 600, 765, and 850 Mev/c. Cross sections for the reaction were obtained, and parity of the Y_1^* resonance, observed at 1660 Mev, was derived by means of an impulse model. (C.E.S.)

2667 DEUTERON PRODUCTION IN p-p COLLISIONS IN THE RANGE 1.5 TO 2.5 Bev. F. Turkot, G. B. Collins, and T. Fujii (Brookhaven National Lab., Upton, N. Y.). Phys. Rev. Letters, 11: 474-6(Nov. 15, 1963).

The $p + p \rightarrow d + \pi^+$ reaction was investigated at incident energies of 1.5–2.5 Bev. The absolute differential cross section of the reaction was determined. A sharp rise was found in the cross section, and this effect is interpreted quantitatively in terms of a one-pion-exchange model and the isospin I = ³⁄₂ resonance in π^+p scattering at 1.35 Bev. (C.E.S.)

2668 INTERMEDIATE BOSON PAIR PRODUCTION AS A MEANS FOR DETERMINING ITS MAGNETIC MO-

MENT. S. M. Berman and Y. S. Tsai (Stanford Univ., Calif.). Phys. Rev. Letters, 11: 483-7(Nov. 15, 1963).

It is shown that, under the assumption of zero anomalous quadrupole moment, the photproduction of intermediate boson pairs on protons has a cross section that is very sensitive to the magnetic moment. The photoproduction cross section for intermediate boson pairs on iron is also calculated. (C.E.S.)

2669 DIRECT MEASUREMENT OF THE g-FACTOR ANOMALY OF FREE ELECTRONS. P. S. Farago, R. B. Gardiner, J. Muir, and A. G. A. Rae (Univ. of Edinburgh). Proc. Phys. Soc. (London), 82: 493-500(Oct. 1, 1963).

Experiments were carried out for the determination of the g-factor anomaly of free electrons. The variation of the polarization of an electron beam was measured in crossed static electric and magnetic fields as a function of the number of orbital loops described by the electrons. A result $\frac{1}{2}(g-2) = (1.153 \pm 0.023) \times 10^{-3}$ was obtained, in good agreement with theory. The accuracy falls short of that obtained by Crane's group; significant improvement could be reached only at the expense of sacrificing the simplicity of the method and its straightforward evaluation. (auth)

2670 A NOTE ON THE THEORY OF PAIRING CORRELATIONS. M. R. Bhagavan (The University, Manchester, Eng.). Proc. Phys. Soc. (London), 82: 605-10 (Oct. 1, 1963).

It is shown that the Hartree-Bogolyubov theory of pairing correlations leads, in a clear and consistent manner, to a generalization of the Green function method of Gor'kov. (auth)

2671 CONTRIBUTIONS OF $K\bar{K}$ INTERMEDIATE STATE TO NUCLEON FORM FACTORS. Ghanshyam Prasad Singh (Tokyo Univ.). Progr. Theoret. Phys. (Kyoto), 30: 327-42(Sept. 1963).

An attempt is made to estimate the contribution of the $K\bar{K}$ intermediate state to the nucleon form factor, using an approximate representation for K-N scattering and the form factor of kaon under bi-pion and tri-pion approximations of γ-K vertex. The representation for K-N scattering is obtained under the assumption that this scattering is dominated by Λ and Σ poles and Y_0^*, Y_1^*, ρ, and ω resonances. An effective range analysis is performed to determine the contribution from Y* terms and also to estimate coupling constants needed in the calculation. $P_{KN\Lambda}$ and $P_{KN\Sigma}$ are assumed odd and Y_0^* and Y_1^* are assigned spins $\frac{1}{2}$ and $\frac{3}{2}$, respectively. Results show that $K\bar{K}$ contributions to nucleon form factors are quite small, thus confirming the results of previous calculation based on perturbation theory. This is particularly significant in view of the fact that the form factors of the kaon, as obtained here, are quite large. The conclusion cannot be taken too seriously because the validity of the K-N scattering representation is uncertain. (auth)

2672 AN APPROACH TO THE PROBLEM OF BOUND STATES. [PART] I. Mineo Ikeda (Hiroshima Univ.), Takayoshi Maekawa, Yoshihiko Miyachi, Kei Senba, and Naomi Shohno. Progr. Theoret. Phys. (Kyoto), 30: 343-69 (Sept. 1963).

An approach, which has some connection with the Tamm-Dancoff method, is proposed for treating the problem of bound states. In the framework of the relativistic field theory, the particle-antiparticle two-body system is discussed in the vector four-Fermion interaction containing form factor. The integral equations in the momentum representation are derived for all singlet and triplet states, and a partial wave analysis is made. The solutions are obtained for all the possible bound states ($^1S_0$, $^3P_0$, $^3P_1$, and $^3S_1 + {}^3D_1$) in the special case of contact interaction. An unfamiliar feature appears in the $^1S_0$ state. (auth)

2673 NEW DESCRIPTION OF THE STRANGENESS CHANGING WEAK INTERACTIONS. Yasuhisa Katayama and Ken-iti Matumoto (Kyoto Univ.). Progr. Theoret Phys. (Kyoto), 30: 383-99(Sept. 1963).

A new description with the six-body Fermi couplings only for the strangeness changing weak interaction is proposed in order to cover the weak phenomena from the standpoint of Sakata model for elementary particles. A hypothesis that all strangeness changing weak interactions are realized by the primary six-body couplings can fix their coupling type, which gives fairly good ratios of K_{e3} decay; $R(K^0_{1e3})/R(K^0_{2e3}) = 9$ and $R(K^+_{e3})/R(K^0_{2e3}) = 0.5$. From the assumption that the Λ-particle to neutron transition induces the strangeness conserving weak interaction, the approximate $\Delta|T| = \frac{1}{2}$ rule in the non-leptonic decays can be interpreted from this type of the six-body coupling in co-operation with the strong interaction. The variety of the asymmetries of the hyperon decays is also explained along the same line of interpretation. (auth)

2674 FIRST RESONANCES IN THE VIOLATED UNITARY SYMMETRY. Masataka Hosoda (Tokyo Univ. of Education). Progr. Theoret. Phys. (Kyoto), 30: 400-1 (Sept. 1963).

The type of resonances that appear in the boson and baryon systems in the static approximation is discussed in the framework of the unitary symmetry U(3) group. The mass differences between the baryons and bosons are taken into account. It is assumed that the deviation from the symmetry properties of the U(3) group will appear in the mass differences but not in the coupling constants between baryons and bosons in conformity with the Fermi-Yang-Sakata model. (C.E.S.)

2675 NON-SHRINKING DIFFRACTION SCATTERING AND THE NAMBU-SUGAWARA-MIYAZAWA HYPOTHESIS. Hirotaka Sugawara (Tokyo Univ.). Progr. Theoret. Phys. (Kyoto), 30: 404-6(Sept. 1963).

A partial proof of the Nambu-Sugawara-Miyazawa hypothesis is given. On the basis of unitarity and analyticity it is shown that if $\alpha' p\ (0) = 0$ then the vacuum pole trajectory in the Regge-Pomeranchuk hypothesis $\alpha p(t) = 1$. It is also proved that the unitarity and analyticity are not sufficient conditions to bound the total cross sections in the high energy limit. If $\alpha p(t) = 1$ the non-shrinkage diffraction scattering in the high energy limit is obtained. (C.E.S.)

2676 ON THE CLASSIFICATION OF BARYON ISOBARS. Naohiko Masuda (Tokyo Univ. of Education). Progr. Theoret. Phys. (Kyoto), 30: 406-7(Sept. 1963).

Baryon isobars are classified by U(3) group and Regge pole trajectory. (C.E.S.)

2677 ON THE NEW POSSIBLE HYPERON RESONANCES Y_1^{***} AND Ξ^{***}. Chong-shou Gao (Peking Univ.). Sci. Sinica (Peking), 12: 1393-5(Sept. 1963).

The existence of the hyperon resonances N^{***}, Y_0^{***}, Y_1^{***}, and Ξ^{***} with spin-parity $\frac{5}{2}^+$ is discussed. The isobaric spin and strangeness numbers are given along with the mass, real part of the slope of the Regge trajectory, and experimental and theoretical widths. (C.E.S.)

2678 THE REGGE BEHAVIOR OF THE SCATTERING AMPLITUDE FOR A HIGHLY SINGULAR POTENTIAL. Yuan-ben Dai. Sci. Sinica (Peking), 12: 1395-8(Sept. 1963).

A potential that is repulsive near the origin is considered and the Regge asymptotic behavior of the scattering amplitude is developed. (C.E.S.)

2679 RADIATION DIFFUSION IN SEMI-INFINITE MEDIUM WITH NONISOTROPIC SCATTERING. [PART] II.

I. N. Minin. Vestn. Leningr. Univ., No. 13, Ser. Mat. Mekh. i Astron., No. 3, 106-18(1963). (In Russian)

The problem of diffusion of radiation in a semi-infinite medium with non-spherical index of scattering is considered with the aid of the probabilistic method. The solution of the integral equation is shown. Particular cases are considered. (auth)

2680 N-N SCATTERING AT 4 Bev LABORATORY ENERGY. Shih Chen and Yuang-beng Dai. Wu Li Hsueh Pao, 19: 398-403(June 1963). (In Chinese)

The expression of the absorptive part of the nucleon-nucleon scattering amplitude in the strip approximation is given. Utilizing the experimental data of low energy π-N scattering, the total cross section of N–N inelastic scattering at 4 Bev laboratory energy is calculated. For p-p scattering $\sigma_{in} = 25$ mb, in agreement with experimental data. The isotopic spin dependence is important in the energy region 3–4 Bev. The result shows that the internal part of the spectral function may also be important. (auth)

2681 MASS SPECTRUM OF THE BARYONS. Chen-pon Liu. Wu Li Hsueh Pao, 19: 613-16(Sept. 1963). (In Chinese)

2682 STUDIES ON X-AGENT. XXXI. SYMMETRICAL SCATTERING OF X-AGENT AROUND WATER. Hideo Moriyama (Shonan Hygiene Inst., Kamakura, Japan). Yokohama Med. Bull., 14: 175-83(Aug. 1963).

Apparent transmittance-changes in the frosted glass surface of four absorption cells located around a bottle of water were investigated to study X-agent scattering. The changes are frequently pronounced in the absorption cells located on the north side and also on the south side of the water, whereas in the cells placed on the west and on the east side they are not so pronounced. This fact is in accord with the concept that the X-agent is inclined to run in a direction extending north and south and that the agent is scattered by water as the Compton effect. Thus it can be inferred that the X-agent, advancing along a north-south direction, is scattered by the water as the Compton effect so that the change may be striking on both north and south sides, resulting in the marked change in the cells located on these two sides. Such a symmetrical scattering is not special to water, but water appears most adequate to demonstrate the pattern, suggesting some particular connection of the X-agent with water. Water seems to be readily activated by X-agent and the activated state appears to be maintained for a considerable long period of time. A diurnal fluctuation is demonstrated in the X-agent in its action on the frosted glass surface. The change is generally marked near noon. (auth)

2683 RECENT DEVELOPMENTS IN SCATTERING MATRIX THEORY OF PARTICLES AND RESONANCES. A. O. Barut (Univ. of Colorado, Boulder). p.113-37 of "Lectures in Theoretical Physics. Vol. V." New York, Interscience Publishers, 1963.

Recent work on strongly interacting particles within the framework of the analytically continued S-matrix theory is reviewed. Systematic developments of the S-matrix theory are outlined. Analyticity in angular momentum and the elementary versus the composite nature of the fundamental particles are discussed. Attempts to calculate the masses of particles and resonances, and the methods used are described. (C.E.S.)

2684 SUMMARY OF EXPERIMENTAL DATA ON THE $\Delta S = \Delta Q$ SELECTION RULE AND THE $K_1^0 - K_2^0$ MASS DIFFERENCE. W. F. Fry (Univ. of Wisconsin, Madison). 15p. (CONF-231-2)

From International Conference on Fundamental Aspects of Weak Interactions, Upton, N. Y., Sept. 1963.

A review of experimental tests of the $\Delta S = \Delta Q$ selection rule presents strong evidence for the violation of the rule for vector currents. Data on K_{e4}^+ decays, however, show that the rule is valid, in the first approximation, for axial vector currents. An examination of experiments on the $K_1^0 - K_2^0$ mass difference shows that the experiments that use the time dependence of the $\bar{K}^0$ component agree, while experiments using K_1^0 regeneration are in agreement, but give a lower value of the difference. (D.C.W.)

Field Theory and Quantum Mechanics

2685 (TID-19672) DEGENERATE SYSTEMS AND MASS SINGULARITIES. T. D. Lee and M. Nauenberg (Columbia Univ., New York). [1962]. Contract AT(30-3)-187. 50p.

For a system with degenerate energies, the power series expansions of the s-matrix elements may become singular. An elementary quantum mechanical theorem is proved which shows that under certain general conditions such singularities do not appear in the power series expansions of the transition probabilities, provided these are averaged over an appropriate ensemble of degenerate states. Application of the theorem leads to cancellations of mass singularities and infra-red divergences in quantum electrodynamics. The possibility of a charged particle with zero mass is considered. (auth)

2686 NUMERICAL SOLUTION OF THE HARTREE-FOCK EQUATIONS. Charlotte Froese (Univ. of British Columbia, Vancouver). Can. J. Phys., 41: 1895-1910(Nov. 1963).

Procedures for solving the Hartree-Fock equations on an automatic computer such as the IBM 7090 are described. Particular attention is given to the question of numerical accuracy and to the problem of devising automatic procedures. (auth)

2687 REMARKS ON THE TYPE OF VON NEUMANN ALGEBRAS OF LOCAL OBSERVABLES IN QUANTUM FIELD THEORY. Richard V. Kadison (Columbia Univ., New York). J. Math. Phys. (N. Y.), 4: 1511-16(Dec. 1963).

The von Neumann algebras of local observables associated with certain regions of space–time are believed to be factors. It is shown that these algebras are not of finite type. The commutant of the tensor product of two semi-finite von Neumann algebras is analyzed with the aid of this result. The factors in question have the vacuum state as separating and cyclic vector. It is shown that a factor of type I_∞ with I_∞ commutant, and a subfactor of type I_∞ with I_∞ relative commutant have a common separating and cyclic vector. This settles negatively some conjectures aimed at proving that these factors are not of type I. An argument of Araki's showing that the factors associated with certain regions are not of type I is presented in simplified form. (auth)

2688 DETERMINANTAL SOLUTION OF THE FREDHOLM EQUATION WITH GREEN'S FUNCTION KERNEL. Henry Brysk (Adelphi Univ., Garden City, N. Y.). J. Math. Phys. (N. Y.), 4: 1536-8(Dec. 1963).

The Fredholm integral equation with a Green's function type of kernel was transformed by Drukarev into an equivalent Volterra equation. It is now proven that the Neumann series solution of the Volterra equation yields the deter-

minantal solution of the Fredholm equation. Thus, a Born approximation technique suffices to obtain the full Fredholm solution. (auth)

2689 EXTERNAL-MASS SINGULARITY. Noboru Nakanishi (Univ. of Illinois, Urbana). J. Math. Phys. (N. Y.), 4: 1539-41(Dec. 1963).

It is shown by an example that the scattering amplitude may have an external-mass singularity that does not correspond to a threshold for any energy variable. If the external mass exceeds the external-mass singularity, the scattering amplitude (even for the forward scattering) is no longer a boundary value of an analytic function of energy variables in the usual sense. This would mean a deadlock of the S-matrix theory based on the analyticity. An example of a threshold in the non-Euclidean case is given. (auth)

2690 ON CAUSALITY AND LOCALITY IN THE METHOD OF ULHMANN. B. Geyer (Karl-Marx-Universität, Leipzig). Nucl. Phys., 47: 625-32(Sept. 1963). (In German)

The method for eliminating unphysical states in field theories with indefinite metric proposed Uhlmann is studied with respect to macro-causality and locality. It is proved that this method guarantees locality as well as macro-causality by an additional assumption. Moreover, macro-causality and Lorentz-invariance together have the same consequences as micro-causality alone. (auth)

2691 EQUALITY OF RENORMALIZATIONS. K. Just (Univ. of Arizona, Tucson). Nuovo Cimento (10), 29: 997-1002(Sept. 1, 1963).

The factor renormalizing the electric charge of a particle is not only equal to that of any other particle, but also to the factors renormalizing all gravitational coupling constants. This implies a relation among the propagators of all independent fields. (auth)

2692 CONSISTENCY PROBLEMS IN A RECENT MODEL OF HIGH-ENERGY SCATTERING. G. Wanders (Université, Lausanne, Switzerland). Nuovo Cimento (10), 29: 1320-8(Sept. 16, 1963).

The predictions on high-energy scattering, in a model proposed by D. Amati, S. Fubini and A. Stanghellini, were deduced from a homogeneous integral equation for the asymptotic form of the scattering amplitude. It is proved that, in the case of forward scattering, this asymptotic equation is consistent with the basic equation of the model. The normalization of the asymptotic form of the scattering amplitude, which is a nontrivial problem in the model under consideration, is discussed. (auth)

2693 JOST FUNCTIONS FOR THE HARMONIC OSCILLATOR. V. A. Alessandrini (Universidad Nacional, La Plata) and J. J. Giambiagi. Nuovo Cimento (10), 29: 1353-66(Sept. 16, 1963).

The Jost functions for the harmonic oscillator (in one and three dimensions) are computed explicitly. They are entire analytic functions in the complex E plane. Its zeros give the well-known bound states of the system. An integral representation is given for the Jost functions of the perturbed harmonic oscillator. (auth)

2694 MATHEMATICAL STRUCTURE OF A MODEL FOR ASYMPTOTIC NONFORWARD SCATTERING AMPLITUDES. V. DeAlfaro, M. Fiamberti, E. Predazzi, and C. Rossetti (Università, Turin and Istituto Nazionale di Fisica Nucleare, Turin). Nuovo Cimento (10), 29: 1367-1419(Sept. 16, 1963).

The mathematical structure and consequences of a previously proposed model for the asymptotic behavior at fixed angle of the scattering amplitude are investigated and the physical consequences are finally discussed. (auth)

2695 PERTURBATION METHOD FOR THE EXCITED STATES OF THE HARTREE-FOCK OPERATOR. J. Sokoloff (Lockheed Missiles and Space Co., Palo Alto, Calif.). Phys. Letters, 7: 31-2(Oct. 15, 1963).

A perturbation method is proposed for obtaining the excited orbitals of the ground-state Hartree-Fock operator, assuming the ground-state orbitals to be known. The entire Coulomb and exchange operator is treated as a perturbation, and the model Hamiltonian is hydrogenic. The perturbation technique was tested using the ground-state orbitals of neutral helium. (R.E.U.)

2696 NON-LOCAL QUANTUM ELECTRODYNAMICS. M. Lévy (Univ. of Wisconsin, Madison). Phys. Letters, 7: 36-8(Oct. 15, 1963).

A weakly nonlocal form of quantum electrodynamics was investigated. It has the properties of giving finite results to every order of perturbation theory and of containing a finite renormalization of the photon mass that does not violate gauge invariance. (R.E.U.)

2697 CALCULATIONS OF THE REAL PART OF THE SCATTERING AMPLITUDE WHEN THE IMAGINARY PART OF THE ASYMPTOTICS HAS FRACTIONAL POWER. I. I. Levintov (Inst. of Theoretical and Experimental Physics, Moscow). Phys. Letters, 7: 41-2(Oct. 15, 1963).

The calculation of real parts of forward scattering amplitudes for particles and antiparticles at high energies using dispersion relations is discussed. One subtraction is made for spin-averaged forward scattering amplitude. Minor singularities in the l plane, which contribute to the high-energy cross section, are taken into account. (R.E.U.)

2698 AMPLITUDE AND PHASE UNCERTAINTY RELATIONS. W. H. Louisell (Bell Telephone Labs., Murray Hill, N. J.). Phys. Letters, 7: 60-1(Oct. 15, 1963).

Narrow-band radiation is discussed with the waves described by an amplitude and wave function. Quantum operator formulation is discussed in an attempt to carry the wave descriptions into quantum mechanics. (R.E.U.)

2699 EXCHANGE CONTRIBUTIONS TO HIGH ENERGY SCATTERING AND IMAGINARY CHARACTER OF THE ELASTIC AMPLITUDE. L. Van Hove (CERN, Geneva). Phys. Letters, 7: 76-7(Oct. 15, 1963).

It is assumed that the contributions of exchange of the charge conjugation quantum numbers $C = \pm 1$ to the elastic scattering $A + B \rightarrow A + B$ have different asymptotic dependences on s, s = (c.m. energy)^2, such that one is negligible compared to the other for $s \rightarrow +\infty$ and t in a given interval $t_0 \leq t \leq 0$, t = – (c.m. momentum transfer)^2. It is concluded that the elastic scattering amplitude is purely imaginary at high energy in the t interval considered. (R.E.U.)

2700 THE RENORMALIZATION GROUP AND REGGE BEHAVIOUR. J. Nilsson (Chalmers Univ. of Tech., Göteborg). Phys. Letters, 7: 86-8(Oct. 15, 1963).

A model is considered in order to see if Regge's result on the high-energy behavior of scattering amplitudes in nonrelativistic potential theory is also obtained in the relativistic case. The model is a scalar field $\Phi(\chi)$ with mass m and a self-interaction term mg $\Phi^3(\chi)$, where g is a dimensionless coupling constant. Renormalization group methods are applied to partial summations of perturbation expansions and it is concluded that these methods cannot be applied to investigate possible Regge behavior. (R.E.U.)

2701 QUANTUM THEORY OF THE EQUILIBRIUM ORDER PARAMETERS FOR DISORDERED SOLID SOLUTIONS. D. O. Christy and G. L. Hall (Kansas State Univ., Manhattan). Phys. Rev., 132: 1958-63(Dec. 1, 1963).

Equations for the equilibrium order parameters of sub-

stitutional binary alloys are derived from both a classical (bond energy) and a quantum approach. The classical case is presented so as to exhibit that Cowley's equilibrium equations are not valid, principally as a consequence of an incorrect calculation of the internal energy. The work of Flinn is utilized to show that the equilibrium equations have the same form in the classical and the quantum cases. Moreover, the quantum approach is made practical by a simplification of certain integrals which Flinn was unable to evaluate. In both cases, a transition temperature for each atomic distance is found. With these developments, it is now possible to predict order parameters quantum mechanically and to test the predictions directly by x-ray measurements or indirectly by resistivity measurements via Asch and Hall's theory of residual resistivity. Numerical calculations required to compare experiment and theory are not completed, but a presentation of the theory alone seems justified in view of the appearance of these and papers based on Cowley's incorrect equations. (auth)

2702 CORRELATION EFFECTS IN MANY-FERMION SYSTEMS: MULTIPLE-PARTICLE EXCITATION EXPANSION. Hugh P. Kelly and Andrew M. Sessler (Univ. of California, Berkeley). Phys. Rev., 132: 2091-5(Dec. 1, 1963).

The ground-state wave function and energy of a finite system of interacting fermions are expanded in terms of multiple-particle excitations on an uncorrelated zero-order state. The resulting set of coupled equations constitutes a systematic variational generalization of Hartree-Fock theory. Comparison is made with many-body perturbation theory and it is shown that to any order the theory incorporates an infinite number of perturbation theory terms. Solutions of the equations for ground-state atomic systems are discussed and related to previous work using many-body perturbation theory. It is shown that the sums of perturbation terms necessary for convergence are automatically included in the equations for two-particle excitations. Application of the equations to open-shell atoms is described. (auth)

2703 WEAK INTERACTION EFFECTS IN ELECTRODYNAMICS. Richard A. Carhart (Univ. of Wisconsin, Madison). Phys. Rev., 132: 2337-45(Dec. 1, 1963). (TID-18551)

A perturbation calculation with cutoff is performed for electron scattering in an external electromagnetic field to lowest order in the weak interactions, assuming an intermediate vector meson. Renormalization is based on recent general results of Sekine in a theory with a parity nonconserving interaction. The renormalized $\underline{S}$ matrix is then used to obtain a close estimate of the parity impurities present in atomic and molecular states due to the weak interactions of the electrons. In particular the 2^2P admixture to the 2^2S state of hydrogen is found to be about 10^{-12} for reasonable values of the parameters. The calculation agrees with general considerations on electromagnetic properties of leptons advanced by Zel'dovich and Perelomov, but yields an estimate of the hydrogen amplitude smaller by 10^{-3}. A theoretical upper limit of 10^{-18} on the parity impurity of the ground state of O_2 is suggested, well below the experimental upper limit of 3×10^{-8}. (auth)

2704 REPRESENTATION OF PARTICLE STATES IN QUANTUM FIELD THEORY. J. McEwan (Ames Lab., Ames, Iowa). Phys. Rev., 132: 2353-62(Dec. 1, 1963). (IS-699)

The usual axioms of quantum field theory are modified to allow a uniform treatment of stable and unstable particles without making explicit use of asymptotic conditions. A definition is proposed for the physical state of a single, neutral, scalar (or pseudoscalar) boson. The consistency of this definition requires the corresponding one-particle amplitude to satisfy an integral equation whose solutions depend on the mass spectrum and the preparation mechanism of the particle. The unstable particle decay law is obtained from the one-particle amplitude and at very long times appears likely to depend on the details of the preparation. For stable particles, the formulation given is shown to coincide in an asymptotic sense with the well-known Lehmann, Symanzik, and Zimmermann formulation. The generalizations to many-particle states and to particles with spin $\frac{1}{2}$ are indicated. (auth)

2705 NATURE OF THE QUANTUM CORRECTIONS TO THE STATISTICAL MODEL. Herbert Payne (Aerospace Research Labs., Wright-Patterson AFB, Ohio). Phys. Rev., 132: 2544-6(Dec. 15, 1963).

The scheme of correcting the Fermi-Thomas particle density formula by a power series in $\hbar$ is examined through its application to a one-dimensional linear potential, which yields an analytical expression for the exact wave mechanical density for comparison. It is concluded that this is an asymptotic series, valid only where the particle density is large. Furthermore, terms of an oscillatory nature, which may very well transcend the so-called quantum corrections, are missing. A reason for this is offered. (auth)

2706 HIGH-ENERGY SCATTERING AMPLITUDE IN PERTURBATION THEORY. T. L. Trueman and T. Yao (Brookhaven National Lab., Upton, N. Y.). Phys. Rev., 132: 2741-8(Dec. 15, 1963). (BNL-7241)

The consequences of keeping terms in addition to the leading terms in each order of perturbation theory are investigated. The model is the $g\varphi^3$ theory and the method is that of Bjorken and Wu. When the second-most dominant terms in each order of ladder graphs are summed, a second-order pole in the angular momentum plane is obtained and the contribution to the amplitude dominates the sum of leading terms at high energy. When the class of terms to be summed is further enlarged in a well-defined way, the simple Regge behavior is restored. The divergence at threshold in the trajectory function obtained by summing the leading terms is not present in the final result. The question of the high-energy behavior of the complete sum of the ladder graphs is still unsettled. (auth)

2707 USE OF INTENSITY CORRELATIONS TO DETERMINE THE PHASE OF A SCATTERING AMPLITUDE. Marvin L. Goldberger (Princeton Univ., N. J.); Harold W. Lewis, and Kenneth M. Watson. Phys. Rev., 132: 2764-87 (Dec. 15, 1963).

A new technique is described for observing scattered particles in a scattering experiment. This involves a measurement of the correlated counting rates of two detectors and is based on an idea proposed by Hanbury-Brown and Twiss for astronomical observations. With this technique it is possible, for example, to explicitly measure the phase of a scattering amplitude. (auth)

2708 CLUSTER DECOMPOSITION PROPERTIES OF THE S MATRIX. Eyvind H. Wichmann and James H. Crichton (Univ. of California, Berkeley). Phys. Rev., 132: 2788-99(Dec. 15, 1963).

Conditions on the S matrix, which arise from the assumption that it describes interactions that are at least approximately local, are discussed. Particular conditions of this kind, which may be called cluster decomposition properties, are formulated and the implications of these conditions for the structure of the S matrix are studied. The discussion is restricted to the case of a world in which

there is only one kind of particle, namely a spinless boson of finite mass. The considerations presented apply equally well to relativistic, as well as to nonrelativistic scattering theories. It is not assumed that the S matrix can be derived within the framework of a strictly local field theory, nor is it assumed that the S-matrix elements possess any particular properties of analyticity. As an illustration it is pointed out that the cluster decomposition properties assumed hold good in the conventional perturbation theory approach to field theory. (auth)

2709 ON A CONVERGENT MODEL OF QUANTUM ELECTRODYNAMICS. H. A. Ferwerda (Rijksuniversiteit, Groningen, Netherlands). Physica, 29: 999-1012(Sept. 1963).

In order to avoid the ultraviolet divergencies of quantum electrodynamics the propagators and vertices are regularized. The regularization is expressed in terms of an elementary length and gives convergence to any order of perturbation theory. An explicit calculation is given for the self-energy of the electron in lowest order. The singularities of this diagram are discussed. Also a study is made of the self-energy of the photon in lowest order. The gauge invariance of the theory is guaranteed by using the transverse gauge for the photon propagator. (auth)

2710 ENERGY MOMENTS OF SCATTERING PHASE SHIFTS. II. HIGHER PARTIAL WAVES. I. C. Percival and M. J. Roberts (Univ. of London). Proc. Phys. Soc. (London), 82: 519-28(Oct. 1, 1963).

The partition function method of obtaining regularized energy moments of scattering phase shifts is extended to higher partial waves, for potentials V(r) for which $\int_0^\infty dr|V(r)|$ exists and V(r) is an analytic function of r^2 in a neighborhood of the positive real axis. The first three moment relations are given for the p- and d-wave phase shifts. (auth)

2711 ENERGY MOMENTS AND CROSS SECTIONS FOR A GAUSSIAN POTENTIAL. M. J. Roberts (Univ. of London). Proc. Phys. Soc. (London), 82: 594-604(Oct. 1, 1963).

Energy moment relations, derived by Buslaev, Faddeev and Percival, are used to check phase shifts, taking as an example a Gaussian potential. An estimate of the rate of convergence of the asymptotic form of the phase shift is given, and also of truncation errors. Simple approximate cross sections are found in terms of the moment coefficients. Again, using a Gaussian potential, the results showed that the moment approximations were very good for fairly large energies but not so good as the first Born approximation for low energy. (auth)

2712 A VARIATION PRINCIPLE IN THE QUANTUM THEORY OF IRREVERSIBLE PROCESSES. H. Nakano (Univ. of Birmingham, Eng.). Proc. Phys. Soc. (London), 82: 757-77(Nov. 1, 1963).

A variation principle for the exact solution of transport or susceptibility problems is presented. It is equivalent to the exact equation for the density matrix, whereas existing variation principles are based on the Boltzmann equation. Explicit forms are given for typical cases, including the electric conductivity and the electric and magnetic susceptibility. In general the variation principle makes a functional stationary but has no extremum property. However, for coefficients representing a dissipative effect it can be written as a minimum principle. In a perturbation approximation it reduces to the known variation principles. The cases of conductivity in an external magnetic field, and of magnetic resonance in a molecular gas, are discussed. (auth)

2713 ON THE DEFINITION OF THE TOTAL HAMILTONIAN IN THE FIXED-SOURCE THEORY. Yusuke Kato and Nobumichi Mugibayashi (Kobe Univ., Japan). Progr. Theoret. Phys. (Kyoto), 30: 409-11(Sept. 1963).

The total hamiltonian in the theory of a neutral scalar field interacting with a fixed source is defined for $G_2 < \infty$ by a method that does not make use of the unitary operator and is applicable to any other fixed-source theory. (C.E.S.)

2714 SIMPLE HEAT SWITCH FOR LOW TEMPERATURE USE. J. G. Dash and J. Siegwarth (Univ. of Washington, Seattle). Rev. Sci. Instr., 34: 1276-7(Nov. 1963).

The design and performance of a heat switch capable of working in the region 293 to 1°K are presented. The switch consists of a thermal shorting rod between two regions that are thermally isolated. When the rod is in place, thermal conduction is allowed and when removed by a hoist, no heat is allowed to flow. The switch is applied to a He^3 cryostat. (R.E.U.)

2715 THE TIME-DEPENDENT SCATTERING THEORY OF MULTI-CHANNEL PROCESS. Tse-sen Yang (Peking Univ.). Wu Li Hsueh Pao, 19: 239-48(Apr. 1963). (In Chinese)

The time-dependent formal theory of scattering, initiated by Lippmann and Schwinger, is generalized to the case of multi-channel process. Previous generalizations are used, but the simplicity of the L-S formalism is preserved. The explicit form of the scattering operator is given. The calculation of the various transition probability can be made in a similar way as in the original L-S theory. (auth)

2716 THE SPINOR WAVE FUNCTIONS AND OPERATORS IN THE LOCAL COORDINATE SYSTEM. Bai-yu Hou. Wu Li Hsueh Pao, 19: 341-59(June 1963). (In Chinese)

Spinor wave functions are expressed in terms of variables in the coordinate system carried with the particle. The properties of various simple systems are discussed with the help of wave functions or scattering functions expressed in this form. The differential operators are expressed in terms of the infinitesimal rotation operators in the coordinate system carried with the particle. A simple way of separating the variables of various spinor wave equations is given. (auth)

2717 CERTAIN PROPERTIES OF FERMI SYSTEM WITH EQUAL INTERMEDIATE ENERGY LEVELS. Yuweng Yu, Chung-wua Chang, and Min Yu. Wu Li Hsueh Pao, 19: 483-502(Aug. 1963). (In Chinese)

A model for many-body systems of fermions in which each particle has three degrees of freedom and orbital momentum $l_0, l_0-2, \ldots 0$ if l_0 is even or $l_0, l_0-2, \ldots 1$ if l_0 is odd is presented. A δ-type coupling exists between the particles. The structure of the low levels in this model is obtained, and their characteristics and physical representations are investigated. It is shown that the model possesses equal intermediate energy levels. (tr-auth)

2718 BEHAVIOR OF DE BROGLIE WAVES AND WAVE PACKETS. W. H. Furry (Harvard Univ., Cambridge, Mass.). p.1-112 of "Lectures in Theoretical Physics. Vol. V." New York, Interscience Publishers, 1963.

A free particle is considered and the motion of the corresponding waves and wave packets is outlined. The phase-integral approximation and the Feynman path integral are discussed as methods of solution for the wave functions. The motion of a charged particle in a magnetic field is also considered. (C.E.S.)

2719 TOPICS IN QUANTUM ELECTRONICS. N. Bloembergen (Harvard Univ., Cambridge, Mass.).

p.218-57 of "Lectures in Theoretical Physics. Vol. V." New York, Interscience Publishers, 1963.

Fundamental processes in the microwave solid state maser and the optical solid state maser are discussed. Non-linear optics and the quantum mechanical calculation of linear and nonlinear polarizability are considered. Other topics include macroscopic equations with nonlinear polarization, nonlinear coupling between electromagnetic waves, the general laws of reflection and refraction, the polarization and intensities of harmonic waves, and the nonlinear properties of a plasma. (C.E.S.)

2720 MACH'S PRINCIPLE AS BOUNDARY CONDITION FOR EINSTEIN'S FIELD EQUATIONS. John Archibald Wheeler (Princeton Univ., N. J.). p.528-78 of "Lectures in Theoretical Physics. Vol. V." New York, Interscience Publishers, 1963.

An acceptable formulation of Mach's principle with respect to Einstein's field equations is discussed. Three-dimensional geometry and its rate of change in general relativity, Mach's principle and the intrasurface variational principle, and the Taub universe in terms of gravitational radiation of maximal wavelength are considered. (C.E.S.)

Geophysics

2721 (AFCRL-62-312) STUDY OF IONOSPHERIC ABSORPTION DURING A SOLAR ECLIPSE. PART I. SOLAR ECLIPSE. N. Carrara, P. F.Checcacci, and M. T. de Giorgio (Italy. Consiglio Nazionale delle Ricerche. Centro di Studio per la Fisica delle Microonde, Florence). Jan. 1962. Contract AF61(052)-498. 39p. (AD-289037)

Measurements of cosmic noise absorption by the ionosphere using riometers and radiometers revealed a detectable change in the ionospheric absorption on 27.6 Mc during the Feb. 15, 1961, eclipse. The results obtained may be explained in terms of a contribution to the phenomenon arising from the whole ionosphere. The experimental apparatus is described, and the results are displayed. (D.C.W.)

2722 (AID-Report-P-63-28) PHENOMENA IN THE UPPER ATMOSPHERE. Review of Soviet Literature. Report No. 32. (Library of Congress. Aerospace Information Div., Washington, D. C.). Feb. 26, 1963. 15p. (AD-298588)

Thirteen references with abstracts are included for articles published in 1962 on solar radiation, Van Allen belts, telluric currents, atmospheric electricity and nuclear explosions, polar communications, meteorology, and missile and satellite data. (D.C.W.)

2723 (IPPJ-12) INTERACTION OF SOLAR PLASMA STREAMS WITH THE OUTER GEOMAGNETIC FIELD. Tatsuzo Obayashi (Nagoya, Japan. Univ. Inst. of Plasma Physics). May 1963. 22p.

The general nature of the magnetic field surrounding the earth is discussed using various measurements made by space probes since 1958. It is shown that the outer geomagnetic field consists of two regions: the standing shock layer and the geomagnetic cavity. The pattern of these regions in the equatorial plane is shown in a frame fixed to the sun. The shock layer, in which turbulent fluctuations of magnetic field are characteristic, appears beyond 10 earth's radii in the sunward side even in a geomagnetically quiet period. The shape of the shock front (the boundary to a quiescent interplanetary plasma) is approximated as a hyperbola, with a stand-off distance of the order of 5 earth's radii. This standing shock layer is terminated by the geomagnetic field cavity inside, being a spherical shape in the day-side and an elongated tail in the night-side. Also, the axis of symmetry of this pattern seems to be tilted somewhat towards west of the sun. The ordinary shock theory of a continuous flow is applied, assuming that the interacting plasma is magnetized so that the mean free path may be replaced by the Larmor radius of the medium. The theoretical estimations of the shock position and the size of the geomagnetic cavity are then compared with the observed ones. It is found that the observed shock wave is consistent for a supersonic flow of Mach number of 2 to 5. The estimated values of a typical quiescent solar plasma stream are given. (auth)

2724 (FTD-TT-63-968(p.172-99)) CERTAIN PROBLEMS OF INTERPRETING THE RESULTS OF MEASUREMENTS OF OUTGOING RADIATION BY MEANS OF METEOROLOGICAL SATELLITES. K. Ya. Kondrat'ev (Kondrat'yev). Translated from Kosmich. Issled., 1: No. 1, (July-Aug. 1963).

The basic problems of interpreting the results of measurements of outgoing radiation obtained with meteorological satellites are discussed. (auth)

2725 (FTD-TT-63-968(p.200-22)) STRUCTURAL CHARACTERISTICS OF THE RADIATION FIELD OF THE EARTH AS A PLANET. E. (Ye.) P. Borisenkov, Yu. P. Doronin, and K. Ya. Kondrat'ev (Kondrat'yev). Translated from Kosmich. Issled., 1: No. 1, (July-Aug. 1963).

The results of a statistical investigation of fields of outgoing radiation according to measurement data from Tiros II are given. Structural and correlation functions are constructed for each of the 52 orbits. The average and most probable values of the indicated functions are obtained, taking into account the errors in measuring the outgoing radiation. The radiation fields and the meteorological parameters of the atmosphere are compared. The fulfillment of the conditions of isotropy of the analyzed fields is investigated and the structural characteristics of fields of integral outgoing radiation and outgoing radiation in the region of the atmospheric window are compared. (auth)

2726 (FTD-TT-63-968(p.235-47)) INVESTIGATIONS OF THE UPPER ATMOSPHERE WITH SATELLITES COSMOS-3 AND COSMOS-5. 2. LOW-ENERGY PARTICLES. V. I. Krasovskii (Krasovskiy), Yu. I. Gal'perin, N. V. Dzhordzhio, T. M. Mulyarchik, and A. D. Bolyunova. Translated from Kosmich. Issled., 1: No. 1, (July-Aug. 1963).

The results obtained with charged-particle traps and fluorescent-screen electron indicators on the satellites Cosmos-3 and -5 are given. Directed streams of positive ions were detected with an energy appreciably exceeding the thermal energy (apparently within the limits from tens of ev to several kev). The ion flows reached $\sim 10^9$ ions/cm^2 sec steradian. These ions were recorded only at low altitudes in the F region of the ionosphere. The fluorescent-screen indicators recorded electron streams of low energy with different anisotropy in the magnetic field. Electrons with energy less than 5 kev were recorded primarily in the illuminated region of the atmosphere. The distribution of their velocity vectors was almost isotropic, and the intensity weakly depends on height. Electrons with energies of 5 to 50 kev were detected primarily at high geomagnetic latitudes and at great heights, where their flow reaches $\sim 10^8$ electrons per cm^2 sec steradian. In addition, particles of appreciably higher energy with a distinct anisotropy were recorded, indicating that they were captured by the magnetic field. A comparison with the data of the traps indicates that these are electrons. Their omnidirectional

flow reaches 5×10^7 electrons/cm^2 sec at altitudes of 1000 km. (auth)

2727 (FTD-TT-63-968(p.248-55)) INVESTIGATIONS OF THE UPPER ATMOSPHERE WITH SATELLITES COSMOS-3 AND COSMOS-5. 3. HIGH-ENERGY PARTICLES. V. V. Temnyi (Temnyy). Translated from Kosmich. Issled., 1: No. 1, (July-Aug. 1963).

Two regions about the earth were distinguished by a shielded Geiger counter: a region of no captured particles, and a region of captured protons with an energy more than 50 Mev. The boundary of the capture region at heights less than 500 km is determined by atmospheric scattering; at greater heights, it is located along the surface of an equal magnetic field strength. (auth)

2728 (UCRL-Trans-995(L)) EXPLOSIONS IN SANDY GROUNDS. V. M. Tsvetkov. Translated by Sergey Shewchuck (Univ. of California Lawrence Radiation Lab., Livermore), from Zh. Prikl. Mekhan. i Tekhn. Fiz., No. 5, 150-3(1962). 11p.

Measurements were made of the velocity of displacement of ground during the time of camuflet explosion in sandy soils. Relationships were derived for the dependence of the propagation velocity of the maximum on the distance from the explosion center, and for the dependence of the maximum displacement velocity on distance. The results are compared with previous experimental data, and the resulting discrepancy is explained. Relationships are also derived for the time of maximum displacement velocity and for the time of the positive phase of motion. The energy carried by the wave is considered, and pressures and densities achieved in the wave are calculated. The effects of initial pressure on the compression wave parameters were studied. (D.L.C.)

2729 STUDIES ON THE AURORAL SPORADIC E IONIZATION AT SODANKYLÄ. J. Oksman (Geophysical Observatory, Finnish Academy of Science and Letters, Sodankylä, Finland). Ann. Acad. Sci. Fennicae, Ser. A VI, 127: 1-57(1963).

Auroral, geomagnetic, and ionospheric data recorded at Sodankylä were used in this study in order to reveal possible interconnections between the various geophysical phenomena during moderate auroral, geomagnetic, and ionospheric disturbances. Special emphasis is placed upon the phenomena in the lower ionosphere, especially upon the E_s and E_{ss} reflections. Diurnal and seasonal variations in the occurrence of these reflections were studied statistically and the statistics were compared with the corresponding statistics of the auroras and the geomagnetic disturbances. Finally, individual disturbances were studied and conclusions drawn as to the geometry of different reflections found in the ionograms. It is shown that oblique reflections cause many of the traces seen during distrubances, among them the retardation noses of a distinct group of E_s traces. The change from E_s to E_{ss} type of reflection is shown to be often gradual and related to the movement of aurora towards the place of observation. The night E layer is shown to cause typical retardation in the E_s as well as the F trace, and it should be distinguished from the oblique type of E_s. The relation between the E_{ss} and E_{sf} traces seen during disturbances is discussed. (auth)

2730 THE ATMOSPHERE AND NEAR SPACE. Francis S. Johnson and Willis L. Webb. Astronaut. Aerospace Eng., 1: 81-7(Nov. 1963).

A summary is presented of recent accomplishments in atmospheric exploration. Included in the discussion are results on the Meteorological Rocket Network stratospheric wind explorations, internal gravity waves in the lower thermosphere, noctilucent clouds, density and temperature variation patterns in the outer atmosphere, some properties of the ionosphere, micrometeorites and their effects on satellites, and conditions in the interplanetary medium from the Mariner II probe data. (R.E.U.)

2731 LABORATORY SIMULATION OF THE SOLAR WIND MAGNETOSPHERE INTERACTION. F. J. F. Osborne, I. P. Shkarofsky, and J. V. Gore (RCA Victor Co., Ltd., Montreal). Can. J. Phys., 41: 1747-52(Nov. 1963).

A controlled plasma–magnetic field interaction was achieved, the conditions of which are such as to fulfill generally the scaling considerations of some aspects of geophysical phenomena, in particular the initial commencement of a magnetic storm. The preliminary measurements indicate the sweeping action on a magnetic field by a moving plasma; the formation of a magnetic cavity; the motion of the dip pole under perturbed conditions; the stand-off of plasma; a quasi Van Allen belt whose drift westward can be suggested as a ring current mechanism; and a polar trapping region. The correlations between the laboratory observations, geophysical measurements, and related theories, where possible, show no serious discrepancies. (auth)

2732 INVESTIGATIONS DURING 1962 OF THE ALERT ANOMALY IN GEOMAGNETIC VARIATIONS. L. K. Law, J. DeLaurier, F. Andersen, and K. Whitham (Dominion Observatory, Ottawa). Can. J. Phys., 41: 1868-82(Nov. 1963).

Magnetic variations measured at three stations across the strike of the anomaly in electrical conductivity of the earth's mantle near Alert, Ellesmere Island, were analyzed by simple potential theory. The anomalous internal contributions to the magnetic variation vector show striking confinement consistent with an underground current in a northeast-southwest direction at a depth between 50 and 70 km, a few kilometers southeast of Alert. If the anomalous conductor is approximated by a uniform infinite cylinder, the horizontal field response as a function of frequency can then be explained with a conductivity of $\simeq 3 \times 10^{-11}$ e.m.u. and a cylindrical radius of about 50 km. The vertical field response is, however, an unsatisfactory fit to this model. A possible asymmetry is noted based on the hourly range data: this could be explained by the dipping of the real conductor under Ellesmere Island. Preliminary earth potential measurements show that, as expected, the electric field variations are abnormally low at Alert. The gravitational consequences of the cylindrical model are discussed and compared with two profiles from the same region. A Bouguer anomaly is found in the predicted region if certain regional gradients are assumed, but its magnitude is smaller than that predicted from the cylindrical model in hydrostatic equilibrium. It is clear that approximate agreement can be obtained with crustal thinning of some 20 km. The significance of the thermal anomaly thought to be responsible for the electrical conductivity anomaly is discussed briefly. (auth)

2733 BALLOON OBSERVATIONS OF THE EXTENT AND STRUCTURE OF AURORAL-ZONE ELECTRON PRECIPITATION EVENTS. R. R. Brown and J. R. Barcus (Univ. of California, Berkeley). J. Geophys. Res., 68: 6069-77(Nov. 15, 1963).

Simultaneous balloon observations of auroral-zone electron precipitation showed examples of the electron influx increasing with increasing geomagnetic latitudes, both with and without magnetic bay disturbances. Under more disturbed conditions, the x-ray flux recorded exceeded that by the northern balloon, indicated a sharp boundary for the

electron precipitation region as suggested by O'Brien on the basis of satellite measurements. (auth)

2734 THE ELECTRON DENSITY DISTRIBUTION IN THE MAGNETOSPHERE DERIVED FROM WHISTLING ATMOSPHERIC DATA. C. A. Schoute-Vanneck and M. S. Muir (Univ. of Natal, Durban, South Africa). J. Geophys. Res., 68: 6079-82(Nov. 15, 1963).

A direct method for calculating the variation in magnetospheric electron density with height from a knowledge of the dispersions of whistling atmospherics at different geomagnetic latitudes is presented. The method is applied to published data on the variation of dispersion with latitude during 1957, and the magnetospheric electron densities for this period are derived. The results are comparable to those obtained by others who used different approaches to the problem. (auth)

2735 FACTORS CONTROLLING THE SHAPE OF THE UPPER F REGION UNDER DAYTIME EQUILIBRIUM CONDITIONS. John S. Nisbet (Pennsylvania State Univ., University Park). J. Geophys. Res., 68: 6099-6112(Nov. 15, 1963).

Equilibrium solutions for the continuity equation for atomic oxygen ions in the upper F region in terms of exponential series are developed that take account of diffusion, the effects of a nondivergent vertical flux of ionization, attenuation of the solar radiation, and lack of temperature equilibrium between the electrons and ions. Above the maximum these series converge rapidly, and they are well approximated by the first few terms. In this way simple solutions of the continuity equation are developed that allow experimentally observed ion- or electron-density profiles to be related to the production, loss, and transport process. Modified solutions that include the effect of helium and hydrogen ions on the electron-density profile are developed. The solutions are used to investigate the effects of assuming different neutral atmospheric models on daytime equilibrium profiles. The implications of the solutions to the analysis of experimental profiles are discussed. (auth)

2736 GEOMAGNETIC AND SOLAR DATA. J. Virginia Lincoln, ed. (National Bureau of Standards, Boulder, Colo.). J. Geophys. Res., 68: 6199-6200(Nov. 15, 1963).

Data are presented for the principal geomagnetic storm sudden commencements for the period April–June 1963. Maximum activity and ranges of the storms are presented. Solar activity characteristics are given for July 1963. (C.E.S.)

2737 NOTE ON RING CURRENTS IN THE ABSENCE OF SUDDEN COMMENCEMENT STORMS. Joan Hirshberg (Lamont Geological Observatory, Palisades, N. Y.). J. Geophys. Res., 68: 6201-2(Nov. 15, 1963).

Evidence is presented for a ring current enhancement associated with the relatively low values of the average amplitude index A_p found in the absence of sudden commencement storms. (C.E.S.)

2738 SOME DEDUCTIONS FROM A MEASUREMENT OF THE HYDROGEN ION DISTRIBUTION IN THE HIGH ATMOSPHERE. W. B. Hanson, T. N. L. Patterson, and S. S. Degaonkar (Southwest Center for Advanced Studies, Dallas). J. Geophys. Res., 68: 6203-5(Nov. 15, 1963).

It is shown that previous measurements of the ion composition above the F_2 peak place constraints on the rate coefficient of the charge exchange reaction $H + O^+ \rightleftharpoons H^+ + O$ and the global distribution of atomic hydrogen. (C.E.S.)

2739 VARIATION OF THE GEOMAGNETIC FIELD WITH SOLAR ACTIVITY AT TUCSON. S. S. Degaonkar (Southwest Center for Advanced Studies, Dallas). J. Geophys. Res., 68: 6206-7(Nov. 15, 1963).

It is shown that a simple analysis of the Tucson observatory magnetic records indicates the 11-year variation with sunspot cycle more clearly than low- and mid-latitude stations. The variation in the horizontal, vertical, and total field is illustrated for the years 1905–1955. (C.E.S.)

2740 6300 Å AIRGLOW INDUCED BY HYDROMAGNETIC WAVES FROM A THERMONUCLEAR EXPLOSION. F. Kirk Odencrantz and Harold E. Cronin (Naval Ordnance Test Station, China Lake, Calif.). J. Geophys. Res., 68: 6210-12(Nov. 15, 1963).

A possible explanation for the enhancement of 6300 Å airglow after the July 9, 1962 high-altitude explosion is presented. It is proposed that the heating of electrons by a hydromagnetic wave originating with the nuclear explosion was responsible for the observed 6300 Å radiation enhancement and that the heating of the thermal electrons by the hydromagnetic wave was able to modify the energy distribution sufficiently to allow excitation of atomic oxygen to the $^1D_0$ state. (C.E.S.)

2741 ATMOSPHERIC HEATING IN THE AURORAL ZONES. Luigi G. Jacchia and Jack Slowey (Smithsonian Astrophysical Observatory, Cambridge, Mass.). Nature, 200: 459-60(Nov. 2, 1963).

The effects of atmospheric heating in the auroral zones were studied during the second half of Jan. and most of Feb. 1963 using a satellite whole perigee which was located in latitudes between 65 and 70 north. Two geomagnetic perturbations of moderate intensity (maximum $K_p = 6^-$ in both cases) on January 31 and February 10, respectively, are shown. Both magnetic storms were accompanied by a large increase in the satellite drag, and even a cursory glance at the magnitude of the atmospheric perturbations shows that the heating was, in each case, several times greater than the heating that would have been expected in lower latitudes. It appears that the temperature on quiet days was closer to 650°C than to the 750°C, which can be deduced from satellite drag at low latitudes. From the data a large systematic increase of upper-atmosphere temperature with latitude seems to be excluded. (P.C.H.)

2742 THEORETICAL INTERPRETATION OF THE EQUATORIAL SPORADIC E LAYERS. K. Maeda (Kyoto Univ.), T. Tsuda, and H. Maeda. Phys. Rev. Letters, 11: 406-7(Nov. 1, 1963).

A theoretical explanation of the echo structure of the equatorial sporadic E layers is presented. The explanation is based on an instability analysis of weakly ionized plasmas. Dip dependence of the electric field in the neighborhood of the dip equator was also studied, and it was concluded that this electric field is distributed in much the same way as the electric current versus dip angles. (C.E.S.)

2743 THE ALBEDO NEUTRON THEORY OF GEOMAGNETICALLY TRAPPED PROTONS. A. M. Lenchek and S. F. Singer (Univ. of Maryland, College Park). Planetary Space Sci., 11: 1151-1208(Oct. 1963).

The neutron albedo theory of geomagnetically trapped protons is reviewed. The intensity, energy spectrum, and angular distribution of fast albedo neutrons emerging from the atmosphere is investigated. Two components may be distinguished: global neutrons that are generated by atmospheric interactions of galactic cosmic rays and polar neutrons that are generated by solar cosmic rays. Each class of neutrons produces a component of trapped protons with distinctive characteristics. The spatial distribution of decaying neutrons in the global component is quite uniform

with respect to altitude and pitch angle over the inner belt, varying only very slowly as compared to the variation of loss rates or lifetimes. The latter were studied for the relevant collision processes. For fast protons the important process is ionization loss in Coulomb interactions. At very high energy absorption in nonelastic nuclear collisions is important. At energies below ~1 Mev charge exchange is important. The lifetimes at low altitudes are therefore governed by the exospheric density. At high altitudes the lifetimes are limited by a breakdown of the trapping condition. The result is a broad belt of high energy protons centered on the magnetic equator with a peak intensity at L ~ 1.5 Earth radii. The polar neutrons generate a proton distribution with quite different characteristics. The mean energy is lower. The saptial distribution has a sharp inner boundary near L = 1.6 and has a minimum intensity in the magnetic equatorial plane. The polar component overlaps the global component and extends to considerably higher altitude. (auth)

2744 AURORAL IONIZATION AND EXCITATION BY INCIDENT ENERGETIC ELECTRONS. Manfred H. Rees (Univ. of Colorado, Boulder). Planetary Space Sci., 11: 1209-18(Oct. 1963).

Ionization in the atmosphere produced by energetic primary auroral electrons in the energy range 0.4 to 300 kev is computed. Three angular distributions for the incident stream are considered: a monodirectional beam, a distribution varying as the cosine of the pitch angle, and an isotropic distribution. The luminosity profiles for the N_2^+ 1 N.G. (0,0) band are predicted for various energy distributions of auroral primaries. Power laws and exponential laws with a range of exponents are investigated: the shape of the luminosity profile is highly sensitive to the energy distribution function adopted. Profiles for a number of electron energy distributions obtained from rocket measurements through auroras are computed showing satisfactory agreement with luminosity variations registered by the rocket borne photometers. (auth)

2745 DISTRIBUTION OF TRAPPED PARTICLES IN A MAGNETIC FIELD. K. D. Cole (Dept. of External Affairs, Melbourne). Planetary Space Sci., 11: 1219-22 (Oct. 1963).

The motion of a charged particle subject to two invariants, its speed and magnetic moment, is applied to derive the number density (n) distribution of a set of such particles in a trapping magnetic (B) tube of force. The distribution is made to relate to that in an element (where B = B′) of the tube where the density of particles per steradian of direction of motion is supposed isotropic or nearly so. It is found that at points of the tube where B > B′, n is constant and where B ≪ B′, n is proportional to B. This is true for a wide range of conditions, viz. when the velocity distribution at B′ is independent of pitch angle. The results are applicable to those geomagnetically trapped particles satisfying the above conditions. The whistler medium may be described by the theory. (auth)

2746 VARIATIONS IN THE DOPPLER PROFILE OF Hα IN AURORAE. O. E. Johansen and A. Omholt (Univ. of Oslo). Planetary Space Sci., 11: 1229-31(Oct. 1963).

Variations in the observed Doppler profile of Hα emitted from high latitude auroras are reported. On one particular night the half-width of the horizon profile ranged from about 15 to 23 Å. The variations are interpreted as changes in the pitch angle and velocity distributions of the incident protons. With an assumed pitch angle distribution of the form $\cos^n \theta$ the index n seems to vary from below 0 to about 6. Theoretical considerations show that this may indicate that the protons are accelerated in the vicinity of the Earth. (auth)

2747 MEASUREMENTS ON ENERGETIC PARTICLES OF THE INNER VAN ALLEN BELT. David J. Knecht and Per F. Dahl. RTD Technol. Briefs, 1: No. 11, 8-13(Nov. 1963).

To test the validity of charged-particle source and loss mechanisms in the inner Van Allen belt charged-particle energy spectra were measured. A plastic scintillator detector for monitoring electron fluxes and a two-crystal spectrometer for proton fluxes were illustrated. Electron and proton energy spectra were given, and their effects on the source and loss mechanism theories were discussed. (C.E.S.)

2748 CALCULATION OF TEMPERATURE AND SOUND VELOCITY IN MIDDLE-STRATOSPHERIC TEMPERATURE MAXIMA FROM NUCLEAR EXPLOSION RECORDINGS. Rudolf Schminder and Christof Junge. Z. Meteorol., 16: 335-6(1963).

The theories and techniques involved in calculating temperature and sound velocity in the middle-stratosphere temperature maximum from nuclear-explosion recordings are described. The recordings were taken in Colm by using a seismograph, an air-pressure variograph, and a microbarograph. (OTS)

2749 REACTOR PHYSICS: THERMAL-NEUTRON SPECTRA. p.39-53 of "Power Reactor Technology. Vol. 6, No. 4."

A review is presented of the calculation of neutron spectra in the range of thermalization. The approximations made to the transport equation in the calculations are discussed. The modified heavy-gas model is described, and comparisons are made of predictions of this model with experiment, using the Nelkin water kernel and the Egelstaff graphite kernel. The calculation of multigroup cross sections and neutron spectra from experimental data reduced into the form of the Egelstaff scattering law is then discussed, the extension by Brugger of the Egelstaff scattering law is considered, and the advantages of the new formulation are indicated. Finally, some of the current scattering kernels for graphite, water, and polyethylene are discussed, and comparisons of the predictions of these models with experiment are given. (D.L.C.)

2750 THE DISTRIBUTION OF ELECTRONS IN THE LOWER AND MIDDLE IONOSPHERE. R. W. Knecht (National Bureau of Standards, Boulder, Colo.). 60p. (CONF-298-1)

From Symposium on the Ionospheric Propagation of Very Low Frequency Radio Waves, Boulder, Colo., Aug. 1963.

A review of current knowledge of the distribution of electrons in the D, E, and lower F regions of the ionosphere is presented. Noteworthy is the increase in the amount of data available on the electron density profile in the D region from ground-based and rocket experiments. Also, the shape of the height profile of electrons in the E and lower F region was significantly refined through the use of improved vertical sounders and by an increasing number of in situ observations. Information was obtained by means of rocket experimentation on the nature of the ionization structures responsible for certain types of sporadic E. (auth)

Low Temperature Physics

2751 SUPERCONDUCTING NIOBIUM FILMS BY VACUUM DEPOSITION. Peter Fowler (National Research Corp., Cambridge, Mass.). J. Appl. Phys., 34: 3538-40 (Dec. 1963).

Niobium films 300 to 150,000 Å thick were formed by vacuum deposition using electron bombardment techniques. The films were superconducting at 4.2°K in magnetic fields

as high as 30 kOe. Critical current density at 4.2°K is in the order of 10^6 amp/cm^2. The superconducting transition temperature, 9.3°K for a 2300-Å thick film, is less for thinner films. Aging effects were noted for the high-field current-carrying capacity. (auth)

2752 PROPERTIES OF SUPERCONDUCTING NIOBIUM FILMS MADE BY ASYMMETRIC ac SPUTTERING. R. Frerichs and C. J. Kircher (Northwestern Univ., Evanston, Ill.). J. Appl. Phys., 34: 3541-3(Dec. 1963).

Superconducting films of niobium can be made by asymmetrical a-c sputtering. This modification of the conventional sputtering process uses a reverse sputtering current to bombard the film as it deposits, thus dislodging gaseous impurities to obtain pure films. The deposition conditions to yield the purest films have been established using cylindrical geometry, that is, Vycor tubing substrates which are heated internally and surrounded by a large niobium cathode. At substrate temperatures of 500°C and with a sputtering to reverse sputtering current density ratio of 4 : 1, films with $\beta = R_{300°K}/R_{10°K}$ as large as 4.7 were obtained from bulk material of $\beta = 14$. Films so made have critical temperatures between 8.9° and 9.2°K; the bulk material critical temperature is 9.25°K. The critical temperature of the films is a strong function of β, falling below 4.2°K for $\beta < 1.25$. (auth)

2753 HARD SUPERCONDUCTING FILMS FROM EXPLODING WIRES. M. Garbuny, M. Gottlieb, and J. J. Conroy (Westinghouse Research Labs., Pittsburgh). J. Appl. Phys., 34: 3642-3(Dec. 1963).

The possibilities of using exploding wire techniques for the preparation of hard superconducting films are discussed. The difficulties of such a process as well as its advantages are discussed. Measurements were performed on a niobium–25% zirconium alloy. (R.E.U.)

2754 THERMAL RESISTIVITY MAXIMUM OF SUPERCONDUCTORS IN THE INTERMEDIATE STATE AND THE PELTIER COOLING BELOW 4°K. Tokio Ohta (Defense Academy, Yokosuka, Japan). Japan. J. Appl. Phys., 2: 663-4(Oct. 1963).

Landau's laminas structure model for a cylindrical superconductor in a transverse magnetic field and an electric field is used. Electrical resistivity in the intermediate state with Peltier cooling is empirically expressed, and the optimum thermoelectric figure of merit is evaluated. (R.E.U.)

2755 ON THE ANALYSIS OF SHORT-RANGE HYPERFRAGMENTS. A. Z. M. Ismail, I. R. Kenyon, A. W. Key, S. Lokanathan, and Y. Prakash (Oxford Univ.). Nuovo Cimento (10), 29: 1019-26(Sept. 1, 1963).

A study of 600 short-range hyperfragments produced in 800 Mev/c K^- reactions was made. Although a few possible examples of the mesic decays of hyperfragments of mass $A \gtrsim 10$ were found, there is little evidence to suggest that they are heavy ($A \gtrsim 40$). A lower limit of about 200 for the nonmesic to mesic branching ratio and an upper limit of about 20 Mev for the Λ^0 binding energy were obtained for these hyperfragments ($A \gtrsim 10$). (auth)

2756 THE PHASE TRANSITION OF A SUPERCONDUCTOR. K. K. Gupta and V. Radhakrishnan (Tata Inst. of Fundamental Research, Bombay). Nuovo Cimento (10), 29: 1120-5(Sept. 1, 1963).

The superconducting phase transition in the absence of an external field is shown to be one of second order with zero latent heat, even if the self-energy effects, due to phonon emission and absorption, are included in the BCS theory of superconductivity. (auth)

2757 FILAMENTARY STRUCTURE IN HARD SUPERCONDUCTORS. B. Y. Tong (Univ. of Hong Kong). Phys. Letters, 7: 14-15(Oct. 15, 1963).

Several theories of the structure of hard superconductors are presented, and resolution is attempted. The training effect, the critical current density and inhomogeneity, directional effects of the field containing the superconductor on the critical current density, resistance in the mixed state, and the abnormal drop of resistance near the normal-state-transformation field value are discussed. (R.E.U.)

2758 PERSISTENT CURRENTS AND ANGULAR MOMENTUM IN SUPERCONDUCTING CYLINDERS. J. E. Mercereau and L. T. Crane (Ford Scientific Lab., Dearborn, Mich.). Phys. Letters, 7: 25-6(Oct. 15, 1963).

Fluxoid conservation for superconducting cylinders of arbitrary geometry is experimentally confirmed by measurements on a 350 Å tin film. (R.E.U.)

2759 FINITE TEMPERATURE EQUILIBRIUM PROPERTIES OF LIQUID He^3 IN FERMI LIQUID THEORY. Peter M. Richards (Clarendon Lab., Oxford). Phys. Rev., 132: 1867-79(Dec. 1, 1963).

Landau's Fermi liquid theory is used to obtain expressions for the respective T^3 and T^2 terms in low-temperature expansions of the specific heat and magnetic susceptibility of liquid He^3 at a temperature T. Such a calculation is essential toward checking the internal consistency of the Fermi liquid theory above 0.05°K; but previously only the zero-temperature limit was considered when working with the Landau parameter, f. Coefficients of the finite-temperature corrections, which are derived, are specific functions of f evaluated on the Fermi surface. Existing experimental data on the pressure dependence of the sound velocity, specific heat, and magnetic susceptibility may be used to assign numerical values to these derivatives under the assumption that f depends only on $|k-k'|$. This method of estimation is believed to place an upper limit to the magnitude of the T^3 term in the specific heat; and its resulting value is more than sufficient to account for the specific heat's deviating from linearity below 0.05°K. The strong curvature in the specific heat versus temperature curve above 0.05°K is thus concluded to be consistent with the Fermi liquid theory. The T^2 term in the magnetic susceptibility contains the same function as occurs in the T^3 term for the specific heat plus an additional correction related to derivatives of the spin-dependent part of f. A reasonable amount of accuracy is expected in the numerical estimate of this latter term. Assuming this to be the case, this theory is in accord with the susceptibility data of Meyer together with the specific-heat data of Brewer or Fairbank, but it cannot reconcile the specific heat data of Wheatley with any existing susceptibility measurements. (auth)

2760 ULTRASONIC ATTENUATION OF TRANSVERSE WAVES IN V, Nb, AND Ta FOR $q\underline{l} < 1$. Moises Levy, Reynold Kagiwada, and Isadore Rudnick (Univ. of California, Los Angeles). Phys. Rev., 132: 2039-46(Dec. 1, 1963).

The temperature dependence of the ultrasonic attenuation coefficient of transverse waves with a wave vector parallel to (1 1 0) was measured in superconducting V, Nb, and Ta. The product of the wave vector times the mean free path ql was smaller than one during these measurements. The sharp drop in the attenuation coefficient below the transition temperature, which is found when $ql > 1$, was not present. The zero-temperature energy gap was found to be $3.6 \pm 0.2\ kT_c$ for V, $3.5 \pm 0.3\ kT_c$ for Nb, and $3.5 \pm 0.2\ kT_c$ for Ta. (auth)

2761 VISCOSITY OF LIQUID He II. J. T. Tough, W. D. McCormick, and J. G. Dash (Univ. of Washington, Seattle). Phys. Rev., 132: 2373-8(Dec. 15, 1963).

The viscosity of liquid He^4 was measured between 1.10°K and the lambda point. A new type of viscometer was used, based on the damping of the transverse vibrations of a fine wire stretched between two rigid supports. The simplicity of the hydrodynamic problem and the low nuisance damping of the wire make this technique particularly appropriate for the measurement of small viscosities. The smoothed data are presented and found to be in good agreement with the latest rotating cylinder viscometer results. In different experimental runs the vibration frequency was varied by a factor of seven and the wire diameter by a factor of three. There was no evidence of systematic trend due to mean-free-path effects or geometrical corrections. (auth)

2762 THEORY OF THE SUPERCONDUCTING TRANSITION TEMPERATURE AND ENERGY GAP FUNCTION OF SUPERPOSED METAL FILMS. N. R. Werthamer (Bell Telephone Labs., Murray Hill, N. J.). Phys. Rev., 132: 2440-5(Dec. 15, 1963).

A calculation is made of the transition temperature of a film sandwich composed of two thin superposed films of different metals, only one of which is superconducting in bulk. Good quantitative agreement is obtained with existing measurements of the dependence of the transition temperature on the thicknesses of the two component films. The problem is shown to be mathematically equivalent to the simple one of the energy levels of a particle in a one-dimensional square potential well. (auth)

2763 THEORY OF PHONON-ASSISTED TUNNELING IN SUPERCONDUCTORS. Leonard Kleinman (Univ. of Pennsylvania, Philadelphia). Phys. Rev., 132: 2484-9 (Dec. 15, 1963).

The current arising from a process in which a phonon is absorbed by a ground-state pair on one side of the oxide barrier resulting in a pair of quasiparticles, one on each side of the barrier, and the transfer of one electron across the barrier is calculated. One-phonon normal and umklapp as well as two-phonon umklapp processes are examined. The one-phonon umklapp process dominates and yields a current in excellent agreement with the experimental excess current both as a function of temperature and of voltage. (auth)

2764 POSITION-DEPENDENT SUPERCONDUCTIVITY. R. H. Parmenter (RCA Labs., Princeton, N. J.). Phys. Rev., 132: 2490-2500(Dec. 15, 1963).

A discussion is given of several methods used in generalizing the Bardeen–Cooper–Schrieffer theory of superconductivity to problems where position dependence plays a key role. It is pointed out that the method in most common use (that of Gorkov) is inappropriate for discussing the rather long-range effects on each other (extending over distances of about 10^{-5} cm) of two metals in contact. A method appropriate for describing such effects is obtained by generalizing the Nakamura theory of position-independent superconductivity. This method leads to results qualitatively similar to those obtained previously by Parmenter using heuristic arguments. The various methods of treating position-dependent superconductivity are all different limiting forms of a very general form of theory due to Blatt, or, in an equivalent but particle-nonconserving form, due to Bogoliubov and Valatin. The saddle-point method of summing cluster expansions, used in both the Blatt and Nakamura theories, is shown to be mathematically justified, in contrast to the situation with most condensed systems. (auth)

2765 EVIDENCE FOR QUANTIZED VORTICES IN A SUPERCONDUCTING STRIP. R. D. Parks and J. M. Mochel (Univ. of Rochester, N. Y.). Phys. Rev. Letters, 11: 354-8(Oct. 15, 1963).

Results of a study of the properties of extremely narrow superconducting film strips in a perpendicular magnetic field are reported. Resistivity vs magnetic field curves obtained in the intermediate state at the transition temperature indicate that quantized current vortices are present, and that in the limit of very narrow strips, their size depends upon the width of the strip. (C.E.S.)

2766 THE VELOCITY OF SOUND IN LIQUID NORMAL AND PARA HYDROGEN AS A FUNCTION OF PRESSURE. A. Van Itterbeek, W. Van Dael, and A. Cops (Instituut voor Lage Temperaturen en Technische Physica, Louvain, Belg.). Physica, 29: 965-73(Sept. 1963).

Measurements are reported on the velocity of ultrasonic pulses in liquid normal and equilibrium hydrogen between 14 and 20.50°K in a pressure range enclosed by the saturated vapor pressure line and the melting curve. Adapting the Tait formula with use of some experimental data of the molar volume the adiabatic compressibility and the ratio of the specific heats were calculated. (auth)

2767 MEISSNER EFFECT AND THE SELF-ENERGY OF THE PHOTON. Osamu Hara (Nihon Univ., Tokyo). Progr. Theoret. Phys. (Kyoto), 30: 370-82(Sept. 1963).

It is pointed out that a close analogy exists between the Meissner effect of the superconductor and the self-energy of the photon. Based on this analogy, it is shown that a gauge invariant self-energy can be obtained by introducing the contributions from the collective motion of the vacuum electrons, just as the gauge invariant theory of the Meissner effect can be obtained by introducing the contribution from the plasma oscillation. Implications of the non-vanishing self-energy are discussed. (auth)

2768 MAGNETIC SHIELDING BY A SUPERCONDUCTING CYLINDER. L. L. Vant-Hull and J. E. Mercereau (California Inst. of Tech., Pasadena). Rev. Sci. Instr., 34: 1238-42(Nov. 1963).

Eddy current magnetic shielding by a rotating conductor was utilized to create a low magnetic field region in the interior of a hollow cylinder. The enhancement of this effect by cooling to the superconducting state was studied and applied to a superconducting device which easily generates and maintains an extremely low magnetic field region as a laboratory environment. The operation of certain commercial Hall probes at helium temperatures is discussed, and a novel method of measuring bulk resistivities as low as 10^{-14} ohm-m is suggested. (auth)

2769 SUPERFLUID HELIUM CONTAINER OF MYLAR CONSTRUCTION. T. H. Moss, C. F. Kellers, and Alan J. Bearden (Cornell Univ., Ithaca, N. Y.). Rev. Sci. Instr., 34: 1267-8(Nov. 1963).

Details are given in the construction of a container for use in x-ray scattering studies from superfluid helium. Epoxy resins are used as the adhesive material for the Mylar sheet. Characteristics particular to this use of Mylar are given. (R.E.U.)

2770 REMOVAL OF TRITIUM FROM He^3. K. L. Erdman, L. P. Robertson, D. Axen, and J. R. MacDonald (Univ. of British Columbia, Vancouver). Rev. Sci. Instr., 34: 1280-1(Nov. 1963).

Desirable concentrations of tritium in commercial He^3 were obtained by adding 1% hydrogen to act as a carrier gas and then freezing the hydrogen and tritium from the mixture at 4.2°K. A schematic of the He^3 purification system is shown. The tritium concentration was reduced from

1.7 parts in 10^8 to 6 ± 2 parts in 10^{11} with an evaporation of 2.5 liters of liquid helium. (R.E.U.)

2771 ON HIGH-CURRENT-SUPERCONDUCTIVITY. Kun-miao Liang and Chang-fu Liu. Wu Li Hsueh Pao, 19: 271-2(Apr. 1963). (In Chinese)

2772 THE DEPENDENCE OF THE UPPER CRITICAL FIELD OF NIOBIUM ON TEMPERATURE AND RESISTIVITY. E. S. Rosenblum, S. H. Autler, and K. H. Gooen (Massachusetts Inst. of Tech., Cambridge). 15p. (CONF-301-10)

From International Conference on the Science of Superconductivity, Hamilton, N. Y., Aug. 1963.

The upper critical field of pure and impure annealed niobium was measured by observing resistive transitions over the range 1.4 to 9.1°K, and 0.035 to 10 μohm-cm. These measurements are well fitted by a derived function for the upper critical field. The form of this function is consistent with the GLAG theory. For pure niobium, the Ginzburg-Landau parameter κ_0 is found to be 1.24 ± 0.05 at 4.2°K and, by extrapolation, $\kappa_0 = 1.6$ at T = 0°K. (auth)

2773 THERMAL AND MAGNETIC PROPERTIES OF SECOND KIND SUPERCONDUCTORS. III. SPECIFIC HEAT OF Nb IN A MAGNETIC FIELD. T. McConville and B. Serin (Rutgers Univ., New Brunswick, N. J.). 16p. (CONF-301-6)

From International Conference on the Science of Superconductivity, Hamilton, N. Y., Aug. 1963.

The specific heat of pure niobium in a magnetic field was measured. The data obtained do not seem to fit in a consistent way into Abrikosov's theory on specific heat discontinuity in superconductors of the second kind. Possible reasons for the observed discrepancies are discussed. (auth)

2774 MAGNETIC AND THERMAL PROPERTIES OF SECOND KIND SUPERCONDUCTORS. II. THERMAL CONDUCTIVITY IN THE MIXED STATE. L. Dubeck, P. Lindenfeld, E. A. Lynton, and H. Rohrer (Rutgers Univ., New Brunswick, N. J.). 9p. (CONF-301-7)

From International Conference on the Science of Superconductivity, Hamilton, N. Y., Aug. 1963.

The magnetic field dependence of the thermal conductivity in Bi–In alloy plates was observed with the heat flow both parallel and perpendicular to the field. For a given sample at the same temperature, the results for both directions were nearly the same. When the heat flow was transverse to the magnetic field and to the current vortex structure of the mixed state, an additional lowering of the conductivity by about 2% was indicated. This was attributed to direct scattering of the heat carrying electrons by the spatial modulation of the energy gap associated with the structure. (auth)

2775 DEFECTS AND MAGNETIC HYSTERESIS IN TYPE II SUPERCONDUCTORS. J. D. Livingston (General Electric Research Lab., Schenectady, N. Y.). 10p. (CONF-301-5)

From International Conference on the Science of Superconductivity, Hamilton, N. Y., Aug. 1963.

The effects of defects on magnetic hysteresis in superconducting lead-base alloys are discussed. Well-annealed specimens show a low-field hysteresis apparently associated with the specimen surface. Dislocations produce a magnetic hysteresis that peaks just below the upper critical field. Precipitates produce considerable hysteresis, and the effects of separately varying the coarseness of the particle dispersion, the volume fraction of precipitate, and the matrix concentration are considered. The results are discussed in terms of the pinning forces between defects and flux threads and the magnetic forces driving flux thread motion. (auth)

2776 ON THE UPPER CRITICAL FIELD OF SOLID SOLUTION ALLOYS OF THE TRANSITION ELEMENTS. C. K. Jones (Westinghouse Research Labs., Pittsburgh); J. K. Hulm, and B. S. Chandrasekhar. 10p. (CONF-301-13)

From International Conference on the Science of Superconductivity, Hamilton, N. Y., Aug. 1963.

Experimental results are presented for the upper critical magnetic fields of London-type superconductors, using Nb and various compositions of Nb–Ti and Nb–Zr solid solution alloys. The experimental results are compared with several theoretical predictions. (T.F.H.)

2777 TREATMENT OF VACUUM CRYOSORPTION. S. M. Kindall (Arnold Engineering Development Center, Tullahoma, Tenn.). 18p. (CONF-209-4)

From American Vacuum Society Meeting, Boston, Oct. 1963.

A new relationship was developed for the pressure response during high vacuum cryosorption. It is based on previously established absorption parameters. The expression describes previously neglected behavior in the transient period through consideration of transient desorptions and applies equally well in the steady-state period. Variations in the rates of adsorption and desorption during steady-state sorption pumping are described in terms of previously established adsorption parameters. Experiments confirmed the validity of previously developed parameters as well as the assumption that volumetric adsorption rate is independent of pressure. (auth)

2778 THE PEAK EFFECT IN SUBSTITUTIONAL AND INTERSTITIAL SOLID SOLUTIONS OF HIGH-FIELD SUPERCONDUCTORS. W. DeSorbo (General Electric Co., Schenectady, N. Y.). 9p. (CONF-301-15)

From International Conference on the Science of Superconductivity, Hamilton, N. Y., Aug. 1963.

It is shown that the peak effect anomaly takes place more readily in interstitial than in substitutional solid solutions of the transition metals. In both materials when the anomaly occurs, it takes place at H_{c2}, the upper critical field for a negative surface energy superconductor (type II), determined magnetically. The results suggest that the presence of solute or impurity atoms segregated at some structural irregularity such as dislocations is important for the appearance of the anomaly. Above H_{c2}, the resistance is probably normal, ohmic resistance. (P.C.H.)

Neutron Physics

2779 (CEA-2346) AUTOMATISATION SUR ORDINATEUR DE LA METHODE DES AIRES PARTIELLES DANS L'ANALYSE DES RESONANCES INDUITES PAR LES NEUTRONS "S". II. AVEC TERME D'INTERFERENCE ET EXTENSION DE LA METHODE AU TRAITEMENT DES MULTIRESONANCES. (Automation on Computer of the Partial Area Method in the Analysis of Resonances Induced by "S" Neutrons. II. With an Interference Term and Extension of the Method to the Treatment of Multiresonances). G. Bianchi and C. R. Corge (France. Commissariat à l'Énergie Atomique. Centre d'Études Nucléaires, Saclay). 1963. 113p.

The numerical analysis on an IBM 7090 computer of transmission resonances induced by s-wave neutrons in time of flight experiments is extended to account for the

interference term. Modifications were made in the programs and subroutines described previously to determine the resonant transmissions from experimental raw data, and the related partial areas. Also, programs that estimate the resonance parameters are described. The field of the partial area method is extended to cover the case where several resonances have to be treated simultaneously, provided they do not interfere. (auth)

2780 (CONF-39-104) A REVIEW OF THE METHODS FOR COMPUTING THERMAL NEUTRON SPECTRA. Henry C. Honeck (Brookhaven National Lab., Upton, N. Y.). June 1963. Contract AT-30-2-GEN-16. 67p.

From American Nuclear Society 9th Annual Meeting, Salt Lake City, June 1963.

The approximation methods for calculating thermal flux distributions and their limitations and applications are described, with emphasis on reactor calculations. Information on computer programs for calculating neutron spectra is included. 180 references. (D.C.W.)

2781 (LADC-5904) IMPROVED ITERATION IN NEUTRON TRANSPORT CALCULATIONS BY ALTERNATING BETWEEN DIFFUSION AND S_n CYCLES. Bengt Carlson (Los Alamos Scientific Lab., N. Mex.). [1963]. Contract W-7405-eng-36. 4p. (CONF-187-21)

From American Nuclear Society Meeting, New York, Nov. 1963.

An inner iteration procedure in transport calculations that entails alternate cycles of simple diffusion and s_n calculations is outlined. Simple diffusion theory in this way becomes numerically embedded in transport theory. A method for explicit solution (without iteration) of the diffusion equations is also sketched. (D.C.W.)

2782 (WAPD-TM-272) P3MG1—A ONE-DIMENSIONAL MULTIGROUP P-3 PROGRAM FOR THE PHILCO-2000 COMPUTER. H. Bohl, Jr., E. M. Gelbard, B. L. Anderson, A. P. Hemphill, and B. P. Peterson (Westinghouse Electric Corp. Bettis Atomic Power Lab., Pittsburgh). Sept. 1963. Contract AT(11-1)-Gen-14. 107p.

The P3MG1 program, which treats fast neutrons by a spherical harmonics approximation up to P_3 and thermal neutrons by a double-P_1 approximation, is described. P_3 elastic scattering is treated exactly for hydrogen only, with the option of including the P_2 and P_3 components of the scattering cross section for other isotopes in the total and transport cross sections. The formulation of the equations permits three geometries — rectangular, cylindrical, and spherical. The basic equations, input forms, problem restrictions, and a sample problem are included. (auth)

2783 (WAPD-TM-396) CTS-3—A MULTI-GROUP TRANSPORT PROGRAM FOR INFINITE CYLINDERS. J. H. Bennett (Westinghouse Electric Corp. Bettis Atomic Power Lab., Pittsburgh). Sept. 1963. Contract AT(11-1)-Gen-14. 18p.

The program CTS-3 provides numerical approximations to solutions of the multigroup transport equation in infinite cylindrical geometry. The discretization used, which is a discrete ordinates method similar to the S_n method, the restrictions imposed by the program, and the preparation of input are described. (auth)

2784 CONSTRUCTION AND ABSOLUTE CALIBRATION OF A PHOTONEUTRON STANDARD. C. P. Galotto. Acta IMEKO (Intern. Messtech. Konf.), Budapest, 1961, 5: 593-605(1961).

A beryllium neutron standard source was constructed. Its activity was $(3.11 \pm 0.07) \times 10^5$ neutrons per second. The beryllium was formed into two interlocking hemispheres with a cavity, which contained the gamma source ($RaBr_2$) that was encapsulated by platinum. The neutron production was by $Be^9 + \gamma \rightarrow n + 2He^4$. The calibration and comparison to N.B.S. are discussed. (R.E.U.)

2785 ON A SIMPLE SOLUTION OF THE GENERAL MULTIGROUP NEUTRON DIFFUSION EQUATIONS. S. E. Suhubi (Technical Univ., Istanbul). Istanbul Tek. Univ. Bul., 16: 67-75(1963).

The solution of the most general integro-differential equations for multigroup neutron diffusion is given for one-group neutrons in finite multiplicative media taking delayed neutrons into consideration. The criticality condition is obtained, and an explicit expression is derived for a flux distribution initiated by sending given neutron fluxes to certain points of the medium. (auth)

2786 REMARKS CONCERNING A PAPER ON THE DINEUTRON. R. Boesch, J. Lang, R. Mueller, and Woelfli (Technische Hochschule, Zurich). J. Phys. Soc. Japan, 18: 1551(Oct. 1963).

The report of a two-neutron state yield in deuteron irradiation of Al was investigated. Analysis of gamma spectra observed at various times after irradiation show no activity corresponding to the decay of Al^{29}, which would have been produced in dineutron capture in Al^{27}. None of the observed activities had the half life of the reportedly observed activity. (D.C.W.)

2787 SOME ASPECTS OF NEUTRON SLOWING-DOWN DISTRIBUTIONS IN HYDROGENEOUS MEDIA. J. J. McInerney (Pennsylvania State Univ., University Park). Nucl. Sci. Eng., 17: 392-7(Nov. 1963).

Some aspects of the relation between the energy dependence of the scattering cross section and the spatial distribution of neutrons slowing down in a hydrogeneous moderator are discussed. The neutron population in an infinite medium was analyzed using the mean square slowing down distance, $\overline{r^2}(E)$, as a measure of its spatial extent. It is shown that, contrary to what is perhaps expected, the neutron population in many cases is distributed closer to its source with decreasing energy. In the analysis of this behavior it was found that diffusion theory may in some cases be expected to give good results close to the spatial position of the source. A correction term was also found for the first flight transport kernel often used in practical calculations. (auth)

2788 A NEW ASYMPTOTIC DIFFUSION THEORY. G. C. Pomraning and M. Clark, Jr. (Massachusetts Inst. of Tech., Cambridge). Trans. Am. Nucl. Soc., 6: 226-7 (Nov. 1963).

2789 SOLUTION OF THE MONOENERGETIC BOLTZMANN EQUATION FOR AN ISOTROPIC POINT SOURCE IN AN INFINITE HOMOGENEOUS ANISOTROPICALLY SCATTERING MEDIUM. K. D. Lathrop (Los Alamos Scientific Lab., N. Mex.). Trans. Am. Nucl. Soc., 6: 227-8(Nov. 1963).

2790 REDUCTION OF TRANSPORT THEORY TO MULTIGROUP DIFFUSION THEORY. G. C. Pomraning (General Electric Co., Pleasanton, Calif.). Trans. Am. Nucl. Soc., 6: 228-9(Nov. 1963).

2791 BOUNDARY CONDITIONS IN GAP GEOMETRY. W. Rothenstein and J. Helholtz (Technion-Israel Inst. of Tech., Haifa). Trans. Am. Nucl. Soc., 6: 229-30(Nov. 1963).

2792 IMPROVED ITERATION IN NEUTRON-TRANSPORT CALCULATIONS BY ALTERNATION BETWEEN DIFFUSION AND Sn CYCLES. Bengt Carlson (Los Alamos

Scientific Lab., N. Mex.). Trans. Am. Nucl. Soc., 6: 230-1 (Nov. 1963).

2793 HOMOGENEOUS-MEDIUM GREEN'S FUNCTIONS APPLIED TO THE TRANSPORT EQUATION IN HETEROGENEOUS MEDIA. John P. Church (E. I. du Pont de Nemours & Co., Aiken, S. C.). Trans. Am. Nucl. Soc., 6: 231(Nov. 1963).

2794 A TRANSPORT THEORETICAL METHOD FOR A CLASS OF PROBLEMS IN SPHERICAL GEOMETRY. A. Leonard (RAND Corp., Santa Monica, Calif.). Trans. Am. Nucl. Soc., 6: 232-3(Nov. 1963).

2795 P_3 BOUNDARY CONDITIONS FOR A TWO-REGION UNSYMMETRICAL SPHERICAL-HARMONICS SOLUTION IN CYLINDRICAL GEOMETRY. Lary D. Noble and John O. Mingle (Kansas State Univ., Manhattan). Trans. Am. Nucl. Soc., 6: 233-4(Nov. 1963).

2796 CADMIUM CUTOFF ENERGIES FOR RESONANCE ABSORBERS IN ACTIVATION AND REACTIVITY MEASUREMENTS. H. L. Brown, Jr., and T. J. Connolly (Stanford Univ., Calif.). Trans. Am. Nucl. Soc., 6: 236-7 (Nov. 1963).

2797 MEASUREMENTS OF THE ANGULAR DISTRIBUTION OF THERMAL NEUTRONS. F. H. Helm (Argonne National Lab., Ill.). Trans. Am. Nucl. Soc., 6: 237-8 (Nov. 1963).

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2799 MEASUREMENT OF THE LINEAR EXTRAPOLATION DISTANCE ØF BLACK CYLINDERS IN EXPONENTIAL EXPERIMENTS. B. K. Malaviya (Harvard Univ., Cambridge, Mass.), T. J. Thompson, and I. Kaplan. Trans. Am. Nucl. Soc., 6: 240(Nov. 1963).

2800 THE AGE OF FISSION NEUTRONS TO INDIUM RESONANCE ENERGY IN WATER. R. K. Paschall (Atomics International, Canoga Park, Calif.). Trans. Am. Nucl. Soc., 6: 241-2(Nov. 1963).

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2808 PULSED EXTRAPOLATION-LENGTH MEASUREMENTS IN GRAPHITE. S. K. Davis, J. A. DeJuren, and M. Reier (Atomics International, Canoga Park, Calif.). Trans. Am. Nucl. Soc., 6: 286-7(Nov. 1963).

2809 EXPERIMENTATION WITH THERMAL-NEUTRON WAVE PROPAGATION. R. B. Perez, R. S. Booth, and R. H. Hartley (Univ. of Florida, Gainesville). Trans. Am. Nucl. Soc., 6: 287-8(Nov. 1963).

2810 A MEASUREMENT OF THERMAL-NEUTRON EXTRAPOLATION LENGTH. E. E. Carroll, Jr., and R. W. Stooksberry (Westinghouse Electric Corp., Pittsburgh). Trans. Am. Nucl. Soc., 6: 289(Nov. 1963).

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2815 NEUTRON SCATTERING BY WATER, TAKING INTO ACCOUNT THE ANISOTROPY OF THE H_2O MOLECULAR VIBRATIONS. J. U. Koppel (General Atomic Div., General Dynamics Corp., San Diego, Calif.). Trans. Am. Nucl. Soc., 6: 293-4(Nov. 1963).

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2818 TEMPERATURE-DEPENDENT SCALAR NEUTRON SPECTRA IN BORATED WATER. G. D. Trimble, J. C. Young, J. R. Beyster, and G. K. Houghton (General Atomic Div., General Dynamics Corp., San Diego, Calif.). Trans. Am. Nucl. Soc., 6: 296(Nov. 1963).

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2820 THE EFFECTS OF COHERENT SCATTERING ON THE THERMALIZATION OF NEUTRONS IN BERYLLIUM. R. R. Fullwood, E. R. Gaerttner, and R. E. Slovacek (Rensselaer Polytechnic Inst., Troy, N. Y.). Trans. Am. Nucl. Soc., 6: 297-8(Nov. 1963).

2821 ASYMPTOTIC NEUTRON SPECTRA IN MULTIPLYING MEDIA. R. E. Slovacek (Rensselaer Polytechnic Inst., Troy, N. Y.), R. R. Fullwood, E. R. Gaerttner, and D. R. Bach. Trans. Am. Nucl. Soc., 6: 298(Nov. 1963).

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2823 MEASUREMENTS OF SCATTERED NEUTRON INTENSITIES FROM CYLINDERS OF C, Cl, Fe, AND Be IN A COLLIMATED BEAM OF NEUTRONS FROM THE TSR-II. F. J. Muckenthaler, K. M. Henry, V. V. Verbinski, M. S. Bokhari, J. J. Manning, and J. L. Hull (Oak Ridge National Lab., Tenn.). Trans. Am. Nucl. Soc., 6: 424(Nov. 1963).

2824 MONTE CARLO CALCULATIONS OF NEUTRON SCATTERING FROM CYLINDERS OF Be, C, Al, AND Fe. F. B. K. Kam, R. S. Hubner, F. H. Clark, and J. G. LaTorre (Oak Ridge National Lab., Tenn.). Trans. Am. Nucl. Soc., 6: 424-6(Nov. 1963).

2825 MONTE CARLO CALCULATIONS OF FAST-NEUTRON PENETRATION IN LITHIUM HYDRIDE. F. H. S. Clark, F. B. K. Kam, and N. A. Betz (Oak Ridge National Lab., Tenn.). Trans. Am. Nucl. Soc., 6: 426-7(Nov. 1963).

2826 SPECTRAL, ANGULAR, AND FLUX DISTRIBUTIONS FOR NEUTRONS IN SEVERAL MATERIALS. F. J. Allen and A. T. Futterer (Ballistics Research Labs., Aberdeen Proving Ground, Md.). Trans. Am. Nucl. Soc., 6: 434-5(Nov. 1963).

2827 AN ANGULAR-DEPENDENT ALBEDO FOR FAST-NEUTRON-REFLECTION CALCULATIONS. R. L. French and M. B. Wells (Radiation Research Associates, Inc., Fort Worth, Tex.). Trans. Am. Nucl. Soc., 6: 435 (Nov. 1963).

2828 A FIRST-LAST COLLISION MODEL OF THE AIR/GROUND INTERFACE EFFECT ON FISSION-NEUTRON DISTRIBUTIONS. R. L. French (Radiation Research Associates, Inc., Fort Worth, Tex.). Trans. Am. Nucl. Soc., 6: 435-6(Nov. 1963).

2829 ANGULAR DISTRIBUTION OF THE AIR-SCATTERED FAST NEUTRON DOSE RATE AT THE AIR/GROUND INTERFACE. M. B. Wells (Radiation Research Associates, Inc., Fort Worth, Tex.). Trans. Am. Nucl. Soc., 6: 436-7(Nov. 1963).

2830 INELASTIC SCATTERING OF NEUTRONS BY ANHARMONIC CRYSTALS. Vinay Ambegaokar (Cornell Univ., Ithaca, N. Y.), John M. Conway, and Gordon Baym. 32p. (CONF-204-4)

From International Conference on Lattice Dynamics, Copenhagen, Aug. 1963.

One-phonon resonances in the inelastic scattering of neutrons by crystals are considered. A method for determining the phonon frequencies and lifetimes is developed. Interference effects occurring when a crystal has anharmonicities are taken into account. It is shown that the Placzek sum rule is a valid guide in substracting the multiphonon background from the experimental cross section. It is suggested that anharmonicities in a crystal place an upper limit on the accuracy with which the phonon frequencies and lifetimes can be determined from the one-phonon resonances. (C.E.S.)

2831 NON LINEAR PROMPT NEUTRON KINETICS IN MULTIGROUP DIFFUSION THEORY. Ajoy Kumar Ghatak. 126p. (CONF-39-102)

From American Nuclear Society 9th Annual Meeting, Salt Lake City, June 1963.

It is shown that in the usual point kinetics formulation of the Fuch's model the assumption that the basic quantity is the ratio of prompt negative temperature coefficient to prompt neutron lifetime is correct in the limit that the higher mode effects can be neglected. The criticality calculation needed to calculate this coefficient is defined. The effect on the Fuch's model when the heat capacity and temperature coefficient vary linearly with temperature and delayed neutrons are taken into account is considered. The higher mode contributions in the presence of temperature feed-back effects are estimated. A method for calculating the space-dependent effects in non-linear kinetics is outlined. An analysis of the transient behavior of the TREAT reactor is also given. (C.E.S.)

Nuclear Properties and Reactions

Refer also to abstracts 2055 and 2058.

2832 (AD-415052) DECAY OF U-235 FISSION PRODUCTS. J. F. Perkins (Redstone Arsenal, Ala. Ordnance Missile Labs.). July 25, 1963. 16p.

The decay properties of mixed fission products from thermal fission of U^{235} were calculated by a method previously used, but with revised input data describing the decay of individual nuclides. Total rates of release of beta and gamma energy and the gamma energy release in each of several energy groups were calculated for decay times from 10^2 to 10^8 sec by summing the contributions from individual nuclides. (auth)

2833 (AEEW-R-266) THE CALCULATION OF GENERALISED DOPPLER FUNCTIONS. V. J. Bell, P. A. C. Buckler, and I. C. Pull (United Kingdom Atomic Energy Authority. Reactor Group. Atomic Energy Establishment, Winfrith, Dorset, England). July 1963. 157p.

The ψ-, ϕ-, and J-functions that arise in the study of absorption in a Doppler broadened resonance are defined, and Fortran computer programs for evaluating their generalized forms are briefly described. Tables of the ψ- and J-functions are included. (D.C.W.)

2834 (AERE-M-1223) PARAMETERS OF THE LOW ENERGY RESONANCES IN THORIUM. C. A. Uttley and R. H. Jones (United Kingdom Atomic Energy Authority. Research Group. Atomic Energy Research Establishment, Harwell, Berks, England). Mar. 1963. 13p.

The radiation and neutron widths for Th^{232} resonances below 350 kev were obtained from neutron transmission measurements using a 120-m flight path on the neutron booster time-of-flight spectrometer. The infinite dilution resonance integral was calculated for each of the resonances for which the parameters were obtained. The contributions to the resonance integral and the disagreement between its experimental and calculated values are also discussed. (D.C.W.)

2835 (BNL-6879) PROPERTIES OF RADIOACTIVE Re^{189}. B. Crasemann, G. T. Emery, W. R. Kane, and M. L. Perlman (Brookhaven National Lab., Upton, N. Y.). Mar. 29, 1963. Contract AT(30-2)-Gen-16. 41p.

The isotope Re^{189} was produced by fast neutron irradiation of osmium and by the (α,p) reaction on tungsten. The rhenium was separated chemically from the target material, and beta, gamma, and internal conversion spectra were measured. The mass assignment is confirmed by the observation of eleven electromagnetic transitions in the Os^{189} daughter, including the 30.8-kev isomeric transition (6 hr), all of which were known from the decay of Ir^{189}. Re^{189} has a half-life of 23.4 ± 1.0 hr and emits beta-ray groups with end-point energies 1000, 780, and 725 kev, and probably others. Results of coincidence measurements lead to some new information about the level scheme of Os^{189}. Evidence was found for strong rotation-particle

coupling between low-lying $K = \frac{1}{2}$ and $K = \frac{3}{2}$ bands in Os^{189}. 40 references. (auth)

2836 (BNL-6887) THE MAGNESIUM-28–ALUMINUM-28 SYSTEM: AN ALUMINUM-28 GENERATOR. Allen J. Weiss and Manny Hillman (Brookhaven National Lab., Upton, N. Y.). Mar. 15, 1963. Contract AT(30-2)-Gen-16. 5p.

A milking method was developed for the production of the short-lived Al^{28} for use in physiological experiments. A Mg^{28} solution is obtained by the irradiation and purification of a Li^6Mg^{28} alloy, and it is placed on a Dowex 50W column in the Na^+ form and then washed with 1 N NaOH. The Al^{28} is eluted in 10 to 30 sec by 1 N NaOH solution containing 0.5 mg/ml of carrier Al. The half lives of Mg^{28} and Al^{28} were determined to be 20.88 ± 0.06 hr and 2.238 ± 0.006 min, respectively. (D.L.C.)

2837 (EANDC(OR)-22L) PROGRESS REPORT TO EANDC FROM DANISH AEC RESEARCH ESTABLISHMENT RISØ FOR THE PERIOD UNTIL SEPTEMBER 1963. O. Kofoed-Hansen, ed. (European-American Nuclear Data Committee and Denmark. Atomenergikommissionen. Forsøgsinstitut, Risø). 31p.

Studies are reported of the development of a neutron collimator-polarizer, thermal neutron cross sections, neutron detection and measurement, the neutron lifetime, neutron magnetic scattering by Fe, and fabrication of Al–LuO and Al–CdO compacts. (T.F.H.)

2838 (EANDC(OR)-23L) PROGRESS REPORT TO EANDC FROM SWEDEN. (European-American Nuclear Data Committee). Aug. 1963. 11p.

Studies are reported on slow- and fast-neutron scattering and reactions, nuclear reactions involving neutrons, fission by neutrons and spontaneous causes, and neutron detection and measurement. (T.F.H.)

2839 (JINR-P-1383) SINREZ IZOROPA 102-GO ELEMENTA S MASSOVYM CHISLOM 256. (Synthesis of Element 102 Isotope With Mass Number 256). E. D. Donets, V. A. Shchegolev, and V. A. Ermakov (Joint Inst. for Nuclear Research, Dubna, U.S.S.R. Lab. of Nuclear Reactions). 1963. 26p.

In the nuclear reaction $U^{238}(Ne^{22},4n)102^{256}$ an α-active isotope of element 102 with mass number 256 has been synthesized. The isotope was detected and identified by the daughter isotope of fermium Fm^{252}. The half life of 102^{256} was found to be close to 8 seconds. The energy dependence of the production cross section of 102^{256} in the reaction $U^{238} + Ne^{22}$ was studied. It has the shape of a curve with the maximum in the region of 112 Mev. The cross section at the maximum point amounts to $\approx 4.5 \times 10^{-32}$ cm^2. The experiments were performed in the internal beam of the 310-cm heavy ion cyclotron of the Laboratory of Nuclear Reactions (Joint Institute for Nuclear Research). (auth)

2840 (NYO-9766) REACTION STUDIES WITH FAST NEUTRONS. D. R. Maxson (Brown Univ., Providence). Nov. 1, 1963. Contract AT(30-1)-1082. 28p.

The modified accelerator performed well at voltages up to 200 kv, and construction of a 350-kv acceleration tube was initiated. An all solid state telescope was completed and a (dE/dx × E) pulse multiplier was almost finished. These instruments will be used with a new analyzer to permit simultaneous recording of (n,p), (n,d), and (n,t) spectra. An analysis of previous data on $Li^7(d,\alpha)He^{5*} \rightarrow \alpha + n$ showed that the first He^5 excited state is at 2.6 ± 0.4 Mev with a width of 4.0 ± 1.0 Mev. The intensity of the excited state relative to that of the ground state was found to be 1.45 ± 0.50. Preliminary angular distributions for the $N^{14}(n,\alpha)B^{11}$ and $O^{16}(n,\alpha)C^{13}$ reactions were obtained. Modifications were made to the counters for these experiments, and electronic equipment associated with the counters and detectors was constructed. (D.C.W.)

2841 (ORNL-3488(p.1-17)) NUCLEAR CHEMISTRY. (Oak Ridge National Lab., Tenn.).

A new nuclear isomer, Ce^{135m}, was discovered and a tentative decay scheme was suggested. A recently discovered nuclear isomer, Ba^{131m}, was produced by a new method, and earlier work on the decay properties was confirmed. Energy spectra and angular distributions of inelastically scattered 11-Mev protons from Ni^{62}, Ni^{64}, Cu^{63}, and Cu^{65} were obtained by use of the tandem Van de Graaff. Three neutron groups were observed in the decay of 4.1-sec N^{17} with energies in Mev (and intensities) of 0.406 ± 0.015 (45%), 1.22 ± 0.02 (45%), and 1.79 ± 0.03 (5%). The results indicate neutron emission from the 5.94-Mev ($\frac{1}{2}^-$), 5.38-Mev ($\frac{3}{2}^-$), and 4.55-Mev ($\frac{3}{2}^-$) levels of O^{17}. The angular correlation of the 613–319-kev gamma-ray cascade in V^{51} was determined. It was fitted to the function $W(\theta) = 1 + (0.013 \pm 0.030)P_2(\cos\theta) - (0.03 \pm 0.05)P_4(\cos\theta)$. The fractional independent fission yield of Sb^{127} was measured to be (5.5 ± 4.2)% in the slow-neutron fission of U^{235}. This leads to a calculated value of 49.5 ± 0.2 for the most probable nuclear charge formed in fission at mass 127 and implies that there is no pronounced 50-proton shell effect on the division of nuclear charge in fission. An upper limit of ~7 barns was measured for the thermal-neutron cross section of the 35-day Nb^{95}. A determination of the half-life of Bi^{209} more precise than previously reported yielded a revised value of 3.68×10^5 yr with a standard error of 1%. Extensive calculations of properties of cadmium, gadolinium, samarium, and boron as neutron filters were completed. Preliminary results for the activation cross section of the 8.0-day I^{131}, $\sigma_{th} \cong 0.7$ barn and $I \cong 8$ barns, were obtained. A redetermination of the neutron-capture cross section of Rh^{105} was undertaken because of the large degree of uncertainty involved in the earlier determination and because a source of enriched Ru^{104} was available that would permit a more accurate measurement to be made by neutron activation. Several samples of Ru^{104} were irradiated in the ORR with a cadmium-ratio technique to produce Pd^{105} and Pd^{106} through neutron capture by the Rh^{105} intermediate. From the ratio of Pd^{106} to Pd^{105} in the separated palladium fraction, measured with a two-stage mass spectrometer, a neutron cross-section value of 25,400 barns for Rh^{105} was determined. A value of 3.65 barns for the neutron cross section of Ru^{104} was indicated by the Pd^{105} and Pd^{106} yields in one irradiated sample. (auth)

2842 (RT/FI(63)37) THE MUON-PAIR PHOTOPRODUCTION EXPERIMENT. A. Alberigi Quaranta, M. De Pretis, G. Marini, A. Odian, G. Stoppini, L. Tau, and G. Ubaldini (Italy. Comitato Nazionale per le Ricerche Nucleari, Frascati Laboratori). June 1963. 89p.

The absolute cross sections for the interaction $\gamma + c \rightarrow \mu^+ + \mu^- + c$ at several energies were measured to probe the muon propagator to small distances. Technical details and the results of the experiment are included. (D.C.W.)

2843 (TID-19193) ATOMIC EFFECTS ON NUCLEAR RESONANCE REACTION YIELD CURVES OF ALUMINUM AND NICKEL. D. G. Costello, J. G. Skofornick, A. I. Morsell, D. W. Palmer, and R. G. Herb (Wisconsin. Univ., Madison). [1963]. Contract [AT(11-1)-Gen-7]. 43p. (CONF-46-108)

From American Physical Society 1963 Spring Meeting, Washington, D. C., Apr. 1963.

Aluminum targets evaporated under a variety of conditions all showed a Lewis peak on the thick-target γ-ray yield curves over the $Al^{27}(p,\gamma)Si^{28}$ resonance reaction at 992 kev. The peaks of all targets prepared at pressures below 4×10^{-7} mm Hg rose above the plateau to a height of about 10% of the plateau yield. Targets prepared at higher pressures showed smaller peaks. Thick-target yield curves from the $Ni^{58}(p,\gamma)Cu^{59}$ resonance reaction at 1424 kev showed a Lewis peak which was about 23% above the plateau yield. Results indicate that nickel targets are much less susceptible to contamination than aluminum. Yield curves were calculated using an improved collision spectrum that takes into account the electron shells of the atom. These calculated curves fit the experimental data much better than previous calculations that treated the electrons in the target as free. Results from these calculations indicate that the point corresponding to one-half the plateau yield, lies about 120 ev below the resonance energy for aluminum and 125 ev below for nickel. Results also indicate that past methods for experimentally determining energy resolution from thick-target yield curves are in error. (auth)

2844 (TID-19654) A RADIOCHEMICAL STUDY OF THE HELIUM-ION INDUCED FISSION OF Pb^{206} (thesis). Robert Lisle Watters (Washington. Univ., Seattle). 1963. 79p.

An unusually high yield of Zn^{72} was detected in the fission of the compound nucleus Po^{210} formed by the 41-Mev helium ion bombardment of Pb^{206}. This yield can be represented as an asymmetric peak for the mass-yield curve. This peak is similar to one found previously for the fission of the Po^{210} compound nucleus formed by bombarding Bi^{209} with 36-Mev protons. The asymmetric peak appears to be caused by closed shell effects in the fragments just before scission. The energy dependence of the Zn^{72} cross section suggests that the peak occurs from the same nuclear species as the symmetric peak. The width at half maximum of the mass-yield curve for symmetric fission was studied for the 31 to 41-Mev helium ion bombardments of Pb^{206}. These widths, when plotted as a function of the excitation energy above the saddle point, have a slope similar to that obtained by Neuzil, but the widths are systematically narrower. (auth)

2845 (TID-19657) STUDY OF NUCLEAR ENERGY LEVELS. Final Technical Report. (Kentucky. Univ., Lexington. Kentucky Research Foundation). Aug. 25, 1963. Contract AT(40-1)-1969. 37p.

An examination of angular distributions and excitation functions for $F^{19}(d,\alpha)O^{17}$ reactions to several O^{17} states indicates that the reactions are determined mainly by the properties of the initial and final states. A preliminary analysis showed that the large difference between measured distributions for $Be^9(d,\alpha)Li^7$ reactions to two nearly identical Li^7 levels could be interpreted in terms of a surface interaction model. Additionally, the spectrum of alpha particles emitted in fast neutron reactions with CsI(Tl) was obtained by using a CsI(Tl) crystal as both target and detector. The results indicate that direct and compound nuclear processes, as well as intermediate processes, contribute to these reactions. The cross section obtained for the $CsI(n,\alpha)$ reaction was the sum of the Cs^{133} and I^{127} cross sections. A technique for observing charged particle energy spectra in neutron reactions with Al^{27}, using targets of about 2 mg/cm² thickness was studied; and the cross section for the $Al^{27}(n,p)Mg^{27}$ reaction at 12.4 to 17.8 Mev was measured. The resulting excitation curve was fitted satisfactorily with the statistical compound nuclear model. (D.C.W.)

2846 (TID-19709) STUDIES RELATING TO SCATTERING OF NEUTRONS AND ALLIED PHENOMENA. Annual Progress Report, 1963. D. M. Van Patter (Bartol Research Foundation, Swarthmore, Penna.). Nov. 6, 1963. Contract AT(30-1)-1679. 38p.

An investigation of the low-lying states of Ni^{58} was initiated, including angular distributions of $Ni^{58}(p,p',\gamma)$ radiations for incident proton energies of 5.0 to 8.0 Mev, and (γ-γ) angular correlations in three octants at 8.0 Mev. Additional information concerning the nuclear structure of Y^{89} was obtained from studies of the radioactive decay schemes of 78.4-hr Zr^{89} and 4.18-min Zr^{89} including a new Zr^{89} decay branch (0.12%) to the 2.53-Mev state of Y^{89}. The ratio of electron capture to positron emission was measured for the primary branch of each of these two isomers. A theoretical study was made of the properties of the Cr^{51} state that is the isobaric analog to the ground state of V^{51}. It was estimated that the M1 γ-transition to the Cr^{51} ground state should be hindered by a factor of ≈30 compared with the single particle estimate. Using the $V^{51}(p,n)$ reaction, an experimental attempt was made to observe this γ-transition; a negative result was obtained, indicating that less than half of the γ-decays of this analog state go directly to the ground state. Experimental measurements of the polarization in the scattering of 3.3-Mev neutrons at 90° from medium-weight elements indicated a change in sign near A = 85, which can now be accounted for by predictions involving the Perey-Buck nonlocal optical potential. Some differences between experiment and theory persist. Attempts were made to observed predicted resonance effects in γ-γ angular correlations for an isotropic hyperfine interaction that should be realizable with a gaseous source. Difficulties associated with the production of a gaseous source in a quartz ampoule at 1000°C were encountered in both the cases of anhydrous $HoCl_3$ and ytterbium metal. A theoretical analysis was made of recently available data for neutrons emitted in coincidence with the spontaneous fission of Cf^{252}. The experimental neutron energy spectrum was found to be in close agreement with a form based on an extended theory of evaporative processes. Values of the level density parameter "a" calculated from the Cf^{252} data were found to agree with values obtained from other experiments. Additional theoretical work was concerned with expressions for nuclear level densities in the region of high angular momentum cut-off. (auth)

2847 (TID-19714) TABLES FOR THE ANALYSIS OF β-γ ANGULAR CORRELATION DATA INVOLVING FIRST-FORBIDDEN β-TRANSITIONS IN A 1^- (β) → 2^+ (γ) → 0^+ CASCADE. R. M. Singru and R. M. Steffen (Purdue Univ., Lafayette, Ind. Physics Dept.). Aug. 1963. Contract AT(11-1)-123. 1245p.

Formulas are presented for the shape factors, anisotropy coefficients, gamma circular polarizations, and parameters representing the contributions of the various nuclear matrix elements for $1^-(\beta) \rightarrow 2^+(\gamma) \rightarrow 0^+$ transitions. The first three quantities are tabulated for a variety of parameters and energies. Vol. I contains values for Tm^{170}, Re^{186}, and Ir^{194}; values for Pr^{144} and Eu^{152} are tabulated in Vol. II. (D.C.W.)

2848 (UCRL-11006) KINETIC ENERGY AND MASS DISTRIBUTIONS FOR NUCLEAR FISSION AT MODERATE EXCITATION ENERGY (thesis). Donald S. Burnett (California. Univ., Berkeley. Lawrence Radiation Lab.). Oct. 7, 1963. Contract W-7405-eng-48. 105p.

Fission fragment kinetic energy measurements using semiconductor detectors were made for the alpha-induced fission of Au^{197}, Bi^{209}, Th^{232}, and U^{238} at alpha energies of 21

to 65 Mev. The data were recorded as the number of events at fragment energies E_1 and E_2, $N(E_1,E_2)$. The data were then transformed into mass–total kinetic energy maps and analyzed by means of moments. The Bi and Au data are in good agreement with quantitative theoretical predictions from the liquid drop model available for the lighter elements. The U and Th data are discussed in terms of qualitative ideas that have been proposed to explain the properties of the fission process for the heavier elements. The changes in the U and Th mass and total kinetic energy distributions with excitation energy are emphasized. Pulse-height energy relations for the detectors used were obtained by a detailed comparison of detector and time-of-flight results for the spontaneous fission of Cf^{252}. 54 references. (auth)

2849 POTENTIAL SCATTERING CROSS SECTION ON NUCLIDES WITH $50 < A < 90$ FOR SLOW NEUTRONS. A. Andreeff (Zentralinstitut für Kernphysik, Rossendorf, Ger.). Ann. Physik (7), 11: 413-16(1963). (In German)

The potential scattering cross sections of V^{51}, Mn^{55}, Fe^{56}, Co^{59}, Ge^{70}, Ge^{72}, Ge^{74}, Se^{76}, Se^{77}, Se^{80}, and Y^{89} were measured for slow neutrons by means of the self-shielding method. The measurements were made at the Rossendorf research reactor, and the research set-up used is shown. The potential cross sections and the calculated "effective" nuclear radius $R' = \sqrt{\sigma_p/4\pi}$ are tabulated. The ratio of the "effective" nuclear radius R' to the geometrical radius $R = r_0 \times A^{1/3}$ (with $r_0 = 1.45 \times 10^{-13}$ cm) was graphed as a function of the mass number. The sharp oscillations of the R'/R values of neighboring nuclides, in opposition to the optical model of spherical nuclei, were surprising. The experimental values, in contrast, are in relatively good qualitative agreement with the calculations of Reif. (tr-auth)

2850 BORN CROSS-SECTIONS FOR SELECTED INELASTIC COLLISIONS OF PROTONS WITH HYDROGEN ATOMS IN STATES UP TO $n = 10$. John Carew (St. John's Univ., Jamaica, N. Y.) and S. N. Milford. Astrophys. J., 138: 772-7(Oct. 1, 1963).

Born total cross sections for inelastic collisions of protons with excited hydrogen atoms may be derived approximately from the Born cross sections for inelastic collisions of electrons with excited hydrogen atoms. A comparison of the exact and approximate Born cross sections for the collisions $p + H(nl) \rightarrow p + H(n'l')$: 1s–2s, 1s–2p, 3s–4p, 3d–4f, shows that they agree down to energies near the Born maximum. By using the known electron cross sections, approximate Born total cross sections are calculated for proton collisions for some of the transitions 1–n'; 2–n'; 3–4, 5; 4–5, 6; 5–6; 10–11. In addition, a simple formula is given for finding other approximate proton cross sections in terms of the approximate electron cross sections calculated recently. (auth)

2851 ON THE ABSENCE OF A 1.5-Mev GAMMA TRANSITION IN THE DECAY OF Pm^{151}. D. G. Burke and M. W. Johns (McMaster Univ., Hamilton, Ont.). Can. J. Phys., 41: 1924-6(Nov. 1963).

It is shown that no 1.5-Mev gamma transition is present in the decay of Pm^{151} with an intensity greater than 2×10^{-3}% per decay. The 1.5-Mev transition previously reported in this decay was assigned to a mixture of two impurities, La^{140} and Pr^{142}. (C.E.S.)

2852 THE FISSION OF Th^{232} BY 14-Mev NEUTRONS AND BY PHOTONS HAVING A MAXIMUM ENERGY $E\gamma$ (MAX) = 90 Mev. A. P. Komar, B. A. Bochagov, and V. I. Fadeev (Ioffe Inst. of Physics, Leningrad). Dokl. Akad. Nauk SSSR, 152: 858-61(Oct. 1, 1963). (In Russian)

The energy distribution of fission fragments at a fixed mass ratio was determined by irradiating a thin target of thorium nitrate (50 to 150 $\mu g/cm^2$) mounted on a collodion film sputtered with Al. A total of 18,000 to 21,000 fission events was analyzed. A contour diagram was plotted with the total kinetic energy of the paired fission fragments E, and the fission mass ratio m_h/m_l (h = heavy, l = light) as coordinates. A hump corresponding to asymmetric fission at a mass ratio of $m_h/m_l = 1.53$ is observed along with another hump corresponding to symmetrical mass fission. The energy and mass distributions of the fission fragments were determined at various angles θ with respect to the neutron or γ-ray beam. The total kinetic energy E at various fixed mass ratios m_h/m_l is given for the angular intervals of 0 to 34°, 34 to 48°, 48 to 60°, 60 to 70°, and 70 to 80°. Two peaks in the total kinetic energy distribution are observed at a mass ratio $m_h/m_l = 1.1$ to 1.3. The positions of both peaks are shifted toward lower energies on increasing m_h/m_l from 1.1 to 1.3. The most probable kinetic energy of symmetrical fission at $m_h/m_l = 1$ to 1.1 is 10 Mev less than the most probable value of E at $m_h/m_l = 1.3$ to 1.4. It is assumed that symmetrical fission shows a smaller value of E than asymmetrical fission. The angular distribution of fission fragment from Th^{232} can be described by the equation: $\sigma(\theta) = 1 + A\cos^2\theta$, where A = 1. The angular anisotropy is $\sigma(0°)/\sigma(90°) = 2$. A transition from two peaks in the energy distribution E at $m_h/m_l = 1.1–1.3$ to a single peak is observed with increasing angle θ. (TTT)

2853 EXPERIMENTAL RESEARCH ON THE MECHANISMS OF SPALLATION. E. Jeannet and J. Rossel (Université, Neuchatel, Switzerland). Helv. Phys. Acta, 36: 560-9(1963). (In French)

Spallation phenomena induced in Cu, Ag, and Pt by high energy neutrons ($E_n = 385$ Mev) were studied by means of metal foils sandwiched between nuclear emulsions. The black tracks of stars are interpreted in terms of cascade and evaporation processes by analyzing the recorded non-isotropic angular distributions. The number of black tracks per star corresponding to the cascade process was found to be independant of A and amounted to ~0.3 for particles of one elementary charge and ~0.6 for charge-two particles. The experimentally derived energy spectrum for the two kinds of emitted particles was smooth and showed the characteristics which are usually interpreted as anomalies of the evaporation process. However the distribution in range dN/dR depicted groups corresponding to deuteron, triton, He^3, He^4, and Li^6 emission which were blurred in the energy representation. This picture removed a number of inconsistancies in the threshold energies and nuclear temperatures. The emission probabilities deduced from it are greater than those obtained by evaporation calculations, in accord with the emission of knocked clusters of nucleons. (auth)

2854 ABSOLUTE MEASUREMENTS OF RADIOACTIVE SOURCE STRENGTHS ACCORDING TO AN IMPROVED METHOD. R. Frosch, P. Huber, F. Widder, and A. Walthert (Universitat, Basel). Helv. Phys. Acta, 36: 622-4 (1963). (In German)

Using the γ–γ coincidence method, three Co^{60} activities were determined absolutely. They were previously compared with three international standards with the help of the 4π–β–γ method. Results showed that the γ–γ coincidence method gives good results. (M.C.G.)

2855 CORRELATION BETWEEN STRUCTURAL ENERGY AND THE PROPERTIES OF THE NATURALLY RADIOACTIVE NUCLEI. A. K. Dutta and B. Pal (Univ. of Calcutta). Indian J. Phys., 37: 313-30(June 1963).

The deviations of the experimentally obtained binding energy of the nuclei from that given by the Bethe-Weiszacker relation were studied for the α- and β-active nuclei in the natural radioactive range. In a previous work these deviations were considered to be the structural energy of the nuclei, according to the generally accepted ideas. It is observed from a graphical representation that the α and β energies, as also their half lives, are intimately connected with the change 'S,' in the structural energy, from the disintegrating to the product nuclei. Suitable relations in terms of the known constituents of the nuclei and the structural energy change 'S' were derived for both the α-energy values and the observed β-energy values. The agreement with observed values is quite satisfactory. It is known that the α-energy values for different nuclei do not come down lower than a value of the order of 4 Mev. The formation of the α particle in the radioactive nucleus is also not properly understood. Based on a scheme for the formation of the α particle, a relation was obtained to determine the lower limit of α-energy values for different nuclei. The observed α-energy values are generally higher than this lower limit, as expected. Further, the half lives of all the even-even and odd-odd nuclei were related to a function of E_α, Z, and N such that they can be calculated with fair agreement. (auth)

2856 PHOTO NEUTRON CROSS SECTIONS IN Na^{23} AND Si^{28}. Kazuo Sato (Tohoku Univ., Sendai). J. Phys. Soc. Japan, 18: 1353-7(Oct. 1963).

Cross sections for the (γ,n) reaction in Na^{23} and Si^{28} were measured using BF_3 proportional counters. For Na^{23}, the cross section shows a rather sharp resonance at 14.4 Mev, and there is evidence in favor of giant resonance splitting. The breaks are observed at 13.1, 14.2, and 15.3 Mev in the $Na^{23}(\gamma,n)Na^{22}$ yield curve. For Si^{28}, the cross section seems to consist of two peaks near 20 Mev; but, as a result of poor statistics, the detailed shape of the cross section is uncertain. (auth)

2857 DECAY OF Ce^{144}. Takeki Iwashita, Takashi Inamura, Yoshio Ikemoto, and Seizaburo Kageyama (Tokyo Univ.). J. Phys. Soc. Japan, 18: 1358-65(Oct. 1963).

The level structure of Pr^{144} was investigated by gamma-gamma coincidence measurements, and the level spins were determined using the gamma-gamma directional correlation method. The 166-kev level proposed by Freeman was confirmed, and a previously unreported 92-kev gamma ray coincident with the 41-kev gamma ray was found. A decay scheme containing the new level is proposed, and a shell model interpretation of the levels is attempted. (auth)

2858 EVALUATION OF THE λ_4 AND λ_5 COULOMB CORRECTION FACTORS IN FIRST-FORBIDDEN β DECAY. S. Margulies and C. Engler (Max-Planck-Institut fur Kernphysik, Heidelberg). Nucl. Instr. Methods, 24: 149-51 (Aug. 1963).

In the equations given by Kotani for the energy and angular dependence of the various observables in first-forbidden β decay, the effects of the Coulomb field of the daughter nucleus on the emitted electron are contained in Coulomb correction factors denoted by λ_i. Tabulations of λ_1 and λ_2 are given by Kotani and Ross. As an aid for the evaluation of experimental data, tables of λ_4 and λ_5 are presented. The first factor appears in both the β-circularly polarized γ correlation and in the longitudinally polarized $\beta-\gamma$ correlation; the second in the transversely polarized $\beta-\gamma$ correlation. With the appearance of these tables, all of the Coulomb corrections found in Kotani's equations are now either given explicitly, or else can be determined by simple multiplication. (auth)

2859 NUCLEAR RECOIL IN 14.8 Mev ENERGY NEUTRON REACTIONS. J. Csikai, P. Bornemisza, and I. Hunyadi (Inst. of Nuclear Research, Hungarian Academy of Sciences, Debrecen). Nucl. Instr. Methods, 24: 227-8 (Aug. 1963).

The breaking off effect of recoil nuclei was investigated from the point of view of the accuracy of activation cross section measurements in 14.8-Mev neutron reactions. The correction factor is given for standard reactions. The range in aluminum of Na^{24} and Mg^{27} arising from 14.8-Mev neutron reactions was examined. The applicability of nuclear recoil technique was investigated for the detection of reactions with fast neutrons. (auth)

2860 INCLUSION OF EXCHANGE EFFECTS IN COLLISION THEORY. F. S. Levin (Rice Univ., Houston, Tex.). Nucl. Phys., 46: 275-83(July 1963).

A derivation of collision theory that incorporates the Pauli principle into the exact transition amplitude is given. The derivation is based on the Green's function method of Feynman and includes both scattering and rearrangement. Results are stated for two simple classes of nuclear reactions. (auth)

2861 EFFECT OF RADIAL MATRIX ELEMENT ON M4 TRANSITION PROBABILITIES. K. Kotajima (Tokyo Univ.). Nucl. Phys., 46: 284-92(July 1963).

Numerical solutions of the single neutron Schrödinger equation for the $h_{11/2-}$ and the $d_{3/2+}$ states in N = 81 nuclei were obtained by using a square well potential and a diffuse potential of the Woods-Saxon type with a spin-orbit interaction. Radial wave functions are obtained with various potential parameters appropriate to this region. Radial matrix elements for the M4 transition are estimated and found to decrease rather smoothly with increasing Z. The effect of the radial matrix element on M4 transition probabilities is discussed on the basis of the calculations. (auth)

2862 NON-COPLANAR QUASI-FREE SCATTERING. Y. Sakamoto (National Research Council, Ottawa). Nucl. Phys., 46: 293-302(July 1963).

It is postulated that the angular correlation distributions of the coplanar and non-coplanar quasi-free proton scattering are controlled by the momentum distribution of the nuclear protons for medium weight nuclei. This assumption differs from that of Jacob and Maris, who suggested that the angular distribution would show a diffraction pattern. The incoming and outgoing protons are represented by waves distorted in a square well potential. It is shown that the two angular correlation distributions are very similar for the same magnitude of momentum transfer. It is also shown that if the distorting potential is real, the angular correlation distributions do not depend on the nuclear protons that have non-zero magnetic quantum number. (auth)

2863 APPLICATION OF CLUSTER MODEL WAVE FUNCTIONS TO THE COULOMB BREAK-UP OF ACCELERATED ^{6}Li IONS. J. M. Hansteen and I. Kanestroem (Univ. of Oslo, Blindern, Norway). Nucl. Phys., 46: 303-20(July 1963).

The total cross section for the Coulomb disintegration of accelerated Li^6 ions into alpha particles and deuterons in the Coulomb field of a heavy target nucleus is studied as a function of the cluster model parameters and of the bombarding energy. It is found that the magnitude of the cross section decisively depends on the degree of cluster overlap in the wave functions. Despite the approximations and uncertainties involved, it is concluded that such investigations might be a useful tool for studying cluster effects in light

nuclei. The need for further measurements is stressed. (auth)

2864 REACTIONS INDUCED BY LOW ENERGY DEUTERON BOMBARDMENT OF B^{11}. B. A. Robson and E. Weigold (Australian National Univ., Canberra). Nucl. Phys., 46: 321-35(July 1963). (ANU-P/279)

The reactions $B^{11}(d,p)B^{12}$ and $B^{11}(d,p)B^{12*}$ are studied in order to investigate the adequacy of the plane wave and distorted wave theories of ordinary stripping for low Q value reactions at low deuteron bombarding energies. Proton angular distributions are presented for deuteron energies of 700 and 1020 kev for the ground state reaction and for deuteron energies of 1020 kev for the excited state reaction. The distorted wave theory gives a good description of these results provided a spin-orbit interaction is assumed in both the initial and final channels. The plane wave theory was found to be inadequate. Data are also given for the angular distributions of alpha particles from the $B^{11}(d,\alpha)Be^{9}$ (ground state) reaction for 700 and 1020 kev deuteron energies. (auth)

2865 A STUDY OF THE REACTIONS $Be^{9}(He^{3},n)C^{11}$, $Li^{7}(He^{3},n)B^{9}$, AND $C^{13}(He^{3},n)O^{15}$. J. L. Duggan, P. D. Miller, and R. F. Gabbard (Oak Ridge National Lab., Tenn.). Nucl. Phys., 46: 336-52(July 1963).

Time-of-flight techniques with time resolution capabilities of 4 ns for neutrons were used to study (He^{3},n) reactions with Be^{9}, Li^{7}, and C^{13}. The angular distributions of neutrons to the ground state and the first four excited states of C^{11} were measured for the reaction $Be^{9}(He^{3},n)C^{11}$ at an incident He^{3} energy of 2.1 Mev. Excitation functions were measured for these states for E_{He^3} from 1.2 to 2.7 Mev at laboratory angles of 0 and 81.5°. For the $Li^{7}(He^{3},n)B^{9}$ reaction an angular distribution was measured at E_{He^3} = 2.1 Mev for the ground state neutron group from B^{9} and the yield curve was measured for this group from 1.2 to 2.7 Mev at 0°. For the $C^{13}(He^{3},n)O^{15}$ reaction resolved neutron groups were seen for transitions to the ground and third excited states in O^{15}. Excitation functions were measured at laboratory angles of 0 and 90° for this reaction for E_{He^3} from 1.2 to 2.7 Mev and angular distributions were measured at E_{He^3} = 2.66 Mev. Distorted wave calculations were made in an attempt to describe all of the reactions. In general, the calculations can be made to fit the angular distributions quite well in the forward direction but the back angle cross sections predicted by the calculations are usually much lower than the measured values. Tentative spin and parity assignments are given for the resolved groups. (auth)

2866 THE CHARGE DEPENDENCE OF NUCLEAR FORCES AND THE DECAY OF O^{14}. L. Lovitch (Istituto Nazionale di Fisica Nucleare, Pisa, Italy). Nucl. Phys., 46: 353-67(July 1963).

A detailed re-examination of the matrix element M_F for the decay of O^{14} is made, taking into account Coulomb and other possible charge dependent forces between nucleons, including the phenomenological potential introduced by Blin-Stoyle and Le Tourneaux. Completely antisymmetrised wave functions are used for the various nuclear states in the calculation. This enhances the charge dependent effects to a small extent as compared with the results of previous calculations. Although the energy levels of the nuclear states involved are not known with great accuracy, the corrections to G_V are insufficient to explain the discrepancy between G_μ and G_V. (auth)

2867 RELATIVE INTENSITIES OF Ga^{72} γ-LINES. V. D. Vitman, N. A. Voinova, and B. S. Dzhelepov (Mendeleev All-Union Research Inst. of Metrology, USSR and Ioffe Inst. of Physics and Tech., Leningrad). Nucl. Phys., 46: 368-76(July 1963).

The Ga^{72} γ spectrum was investigated with an electron-type magnetic γ-spectrometer using recoil electrons. The energies and relative intensities of 38 γ lines were determined. It was checked by measurements of the decay period that they belong to the Ga^{72} spectrum. The results are compared with the data of others. (auth)

2868 MEASUREMENT OF g-FACTORS OF EXCITED STATES IN Cd^{111} AND Pb^{204}. M. Salomon, L. Bostroem, T. Lindqvist, E. Matthias, and Martha Perez (Univ. of Uppsala). Nucl. Phys., 46: 377-82(July 1963).

Using the differential angular correlation method and a magnetic field of about 32 kG, the nuclear g-factors of the 247-kev level in Cd^{111} and of the 1274-kev level in Pb^{204} were measured to be $g = -0.311 \pm 0.015$ and $+0.0565 \pm 0.0020$, respectively. (auth)

2869 POPULATION OF ROTATIONAL STATES BY PROTON INDUCED REACTIONS. G. Bertram Hansen, B. Elbek, K. A. Hagemann, and W. F. Hornyak (Univ. of Copenhagen). Nucl. Phys., 47: 529-43(Sept. 1963).

Spectra of conversion electrons from targets of Tb^{159}, Ho^{165}, and Lu^{175} bombarded with 8 to 12-Mev protons were studied by means of a magnetic spectrometer. At the lower bombarding energies mostly electron lines from rotational states populated by (p,n) reactions were seen. On the basis of the electron lines from proton bombardment of Ho^{165} a partial level scheme for Er^{165} was obtained. At higher bombarding energies the (p,2n) reaction dominates and leads to states in even nuclei. Ground-state rotational bands in Dy^{158}, Er^{164}, Yb^{168}, and Hf^{174} were populated up to the 8^+ state, in Er^{164}, possibly the 10^+ state was seen. The observed intensities of the rotational transitions can be fairly well accounted for by a simple statistical calculation. (auth)

2870 COMPETITION BETWEEN PROTON AND γ-RAY EMISSION IN THE DE-EXCITATION OF THE COMPOUND NUCLEUS. Jean Delorme (Institut de Physique Nucléaire, Lyon). Nucl. Phys., 47: 544-50 (Sept. 1963).

On the basis of the statistical model, an attempt was made to analyze the lower energy part of experimental proton spectra in terms of competition between γ-ray and proton emission. The results were applied to the reaction $Cu^{63}(\alpha,np)Zn^{63}$ and good agreement with experiment was found. (auth)

2871 MEASUREMENTS OF ISOMERIC LIFETIMES IN V^{49} AND W^{180}. W. M. Currie (Univ. of Glasgow). Nucl. Phys., 47: 551-60(Sept. 1963).

By time-to-pulse-height conversion the mean life of the 152-kev level in V^{49} was measured as $(2.97 \pm 0.08) \times 10^{-9}$ sec while that of the 89-kev level in the same nucleus was shown to be less than 7×10^{-10} sec. The mean life of the 102-kev level in W^{180} was measured as $(1.76 \pm 0.04) \times 10^{-9}$ sec, in slight disagreement with the value of $(1.92 \pm 0.07) \times 10^{-9}$ sec recently quoted by Fossan and Herskind. (auth)

2872 MASS AND LEVEL SYSTEMATICS OF $1f_{7/2}$ SHELL NUCLEI. F. Everling (Ames Lab., Ames, Iowa). Nucl. Phys., 47: 561-83(Sept. 1963). (IS-629)

Level schemes of nuclei with constant T_z from 0 to $\frac{7}{2}$ are coordinated by plotting $\Delta + pA$ versus the mass number A, where Δ is the nuclidic mass excess in Mev for ground states and levels and p an arbitrary constant. For overlapping neutron and proton $1f_{7/2}$ shells there may be approximately linear trends within the troups of even, odd, odd-neutron, and odd-proton nuclei. Well established examples are the $J^\pi = \frac{7}{2}^-$ ground states of Sc^{45}, V^{49}, and

Mn^{53}, the 0^+ ground states of Ca^{44}, Ti^{48}, and Cr^{52}, and those of Ti^{46}, Cr^{50}, and Fe^{54}. Extrapolation of the latter trend to Ca^{42} leads to (0.64 ± 0.10)-Mev excitation energy where no 0^+ state is known. This shift of the Ca^{42} ground state is peculiar since the first 2^+ and 4^+ states of Ca^{42}, Ti^{46}, and Cr^{50} behave almost linearly. In self-conjugate nuclei such a shift would be as much as 3 Mev, if the Ca^{40} 3.35-Mev, 0^+ level is not the beginning of a smooth trend, analogous to the apparent build-up of the $1d_{\frac{5}{2}}$ subshell from the O^{16} 6.05-Mev, 0^+ level with a possible exception at Ne^{20}. It cannot be decided yet whether or not most of the trends are destroyed, especially at their beginning, by configuration mixing or other unknown effects. If not, a Ca^{43}(0.32 ± 0.10)-Mev, $\frac{7}{2}^-$ level should exist (provided the 0.374-Mev level has indeed $\frac{5}{2}^-$), and 17 additional requirements listed should apply. The ground states of Ca^{41}, Ca^{42}, Ca^{43}, Sc^{43}, and Ti^{44} may in this case find an explanation as cluster states with Ca^{40} in its ground state. Independently the mass excess of Ni^{56} is predicted by extrapolation from other 28-neutron nuclei to be −53.84 ± 0.05 Mev (C^{12} scale). (auth)

2873 ON ANTISYMMETRIC WAVE FUNCTIONS OF NUCLEON SYSTEMS. [PART] II. K. Fuchs and Kh. Mueller (Zentralinstitut fllr Kernphysik, Rossendorf, Ger.). Nucl. Phys., 47: 548-606(Sept. 1963). (In German)

A special representation of the symmetry matrices is defined and investigated. The projection operators for certain normal forms are introduced. The D ∝ DR relation is generalized. The calculation of simple matrix elements is considered. The symmetry matrices for λ = [3,2] and λ_3 = [2,2,1] are given. (auth)

2874 ENERGY SPECTRA OF PHOTONEUTRONS FROM Al AND NEUTRON EMISSION PROCESSES. C. Milone (Università, Catania, Italy). Nucl. Phys., 47: 607-13(Sept. 1963).

The energy spectra of the photoneutrons emitted from aluminum bombarded with bremsstrahlung are analyzed. The direct emission contributes about 50% to the neutron yield in the region $E_n > 2$ Mev and occurs prevalently at $E_\gamma \approx 16$, 18, 19.4, 21.2, 22.5, and 26.5 Mev. The energy distribution of the evaporated neutrons behaves like the function $F(E_n) \propto E_n \exp(-E_n/T)$ with T ≈ 1.3 Mev. (auth)

2875 ATOMIC EXCITATION ACCOMPANYING THE ELECTRON CAPTURE DECAY OF Er^{165}. H. Ryde, L. Persson, and K. Oelsner-Ryde (Nobel Inst. of Physics, Stockholm). Nucl. Phys., 47: 614-24(Sept. 1963).

In the electron capture process there is a finite probability for atomic excitation or ionization as a consequence of the nuclear charge alteration. An electron capture decay, feeding exclusively the ground state of the daughter nucleus should be ideal for an investigation of this weak effect. The decay of Er^{165} to Ho^{165}, having $T_{\frac{1}{2}}$ = 10.34 h and Q_{EC} = 370 kev, was investigated. The number of K x ray to K x-ray coincidences was measured and the number of double holes in the K shell per K capture was deduced, $P_{KK} = (1.5 \pm 0.4) \times 10^{-5}$. The momentum distribution of the total continuous electron spectrum was studied in an intermediate image beta ray spectrometer. The shape obtained for the electron distribution agrees well with that predicted by the Primakoff and Porter theory, while the intensity for the ejection of K + L + ... electrons was found to be about twice that expected theoretically for the ejection of K electrons in the energy region 80–200 kev. (auth)

2876 SCATTERING OF FAST NEUTRONS FROM NATURAL URANIUM. A. B. Smith (Argonne National Lab., Ill.). Nucl. Phys., 47: 633-51(Sept. 1963).

The elastic and inelastic scattering of fast neutrons from natural uranium is studied. The incident neutron energy is varied from 0.3 to 1.5 Mev. Time-of-flight techniques are utilized to determine the energy spectrum of scattered neutrons. The differential elastic scattering cross section is determined at incident neutron energy intervals of ≲ 50 kev. The cross sections for the inelastic excitations of residual nuclear levels at 45 ± 3, 150 ± 5, 630 ± 20, 720 ± 20, 930 ± 30, 1000 ± 30, and 1050 ± 30 kev are measured. The differential cross section for inelastic scattering to the 45 kev-level is essentially symmetric about 90 degrees. The remaining inelastic groups are emitted isotropically. All cross sections are determined relative to the known elastic scattering cross section of carbon. The experimental results are compared with Hauser-Feshbach theory and possible evidence for direct interaction processes is discussed. (auth)

2877 EXCHANGE TERMS IN DIRECT NUCLEAR REACTION THEORIES. Steve Edwards (Florida State Univ., Tallahassee). Nucl. Phys., 47: 652-70(Sept. 1963).

An internally consistent formulation of the problem of exchange effects in direct nuclear reactions is given. By using convenient Distorted Wave Born Approximation forms, it is shown that in the limit of an infinitely massive target the usual heavy particle stripping matrix elements have the scattering properties that the exchange matrix elements should have. It is thus concluded that these forms are correct, and their properties are discussed in plane-wave and other approximations. (auth)

2878 ORDINARY PERTURBATION THEORY APPLIED TO NUCLEAR MATTER. G. T. Schappert (Massachusetts Inst. of Tech., Cambridge). Nucl. Phys., 47: 671-90(Sept. 1963). (TID-19097; MPI-PA-2/62)

The average binding energy and equilibrium density of nuclear matter are calculated in the self-consistent independent pair approximation. The potentials of Gammel and Thaler are used. The hard core is replaced by a pseudopotential, and the potentials are adjusted to give the same low energy scattering data. The pseudo-potential is of the Huang-Yang type, and hence one can use ordinary Rayleigh-Schroedinger perturbation theory, which is then a joint expansion in the strength of the pseudo-potential plus the central potentials plus the tensor force. The first and second order terms in this expansion were calculated exactly, but were made self-consistent only in the effective mass approximation, the self-consistency requirement becoming the solution of a quadratic equation for the effective mass. It is found that a simple S-wave pseudopotential is not sufficient to produce saturation within a density range corresponding to k_F = 1 to 2 fm^{-1}. A more exact treatment of the hard core gas by means of a pseudo-potential is available from the work of Martin and de Dominicis. Incorporating their results into the perturbation calculation yields saturation for nuclear matter with a binding energy per particle of about 18 Mev at a density corresponding to k_F = 1.4 fm^{-1}. The main results are not so much the actual binding energy and equilibrium density of nuclear matter, but the results of the various contributions coming from second order perturbation theory, especially the interference terms between the pseudopotential and the attractive potentials, and interference terms between direct and exchange matrix elements for the attractive central and tensor forces, which were calculated exactly. (auth)

2879 NUCLEAR RESONANCE EFFECTS IN COULOMB EXCITATION. T. A. Griffy and L. C. Biedenharn (Duke Univ., Durham, N. C.). Nucl. Phys., 47: 691-4(Sept. 1963).

Calculational errors are corrected, and a number of points that were insufficiently discussed in a previous paper with the same title (NSA 16: 19798) are elucidated. (C.E.S.)

2880 FORM AND ANGULAR DISTRIBUTION OF PROTON GROUPS AT Q = 0 Mev IN THE PROTON SPECTRUM OF (d,p) REACTIONS ON HEAVY NUCLEI. J. Pfleger, U. Schmidt-Rohr, V. Spiegel, P. Turek, and W. Zuckschwerdt (Max-Planck-Institut für Kernphysik, Heidelberg). Nucl. Phys., 48: 22-32(Sept. 1963). (In German)

The proton spectra of the (d,p) reactions on heavy nuclei show a pronounced proton group between Q = 0.3 and −1 Mev in addition to the low energy continuum and the gross structure at higher energies. The relative intensity of this proton group increases with decreasing energy of the primary deuterons. From the energy dependence, the A dependence and the angular distribution, it is concluded that this group originates from the $d_{3/2}$, $s_{1/2}$, and $d_{5/2}$ single-particle levels. The results show that the single particle nature of these levels is only slowly disturbed with increasing distance from the closed 126-neutron shell. The distance between these levels increases with the mass number of the nucleus. The shapes of the angular distributions are in agreement with the theory of Coulomb distorted (d,p) reactions. Some of the angular distributions show a structure of the kind discussed by de-Shalit et al. for stripping with associated Coulomb excitation. (auth)

2881 ON THE THEORY OF COLLECTIVE MOTION. Shinzo Nakai (Univ. of Colorado, Boulder and Duke Univ., Durham, N. C.). Nucl. Phys., 48: 45-57(Sept. 1963).

Using the theory of point transformations, Tomonaga's method of describing collective motion is extended to the three-dimensional case. As point transformations are canonical transformations, canonical momenta conjugate to the collective coordinates can be derived. Applying this method, nuclear surface oscillations are investigated. The correspondence with the work of Bohr and the comparison with earlier work are discussed. (auth)

2882 THE DECAY OF Ge^{77}. M. B. Martin and M. L. Wiedenbeck (Univ. of Michigan, Ann Arbor). Nucl. Phys., 48: 65-74(Sept. 1963).

Directional correlation and polarization-direction correlation measurements were done on gamma rays following the decay of Ge^{77}. The results are found to be consistent with previous spin assignments and a spin of 7/2 can be assigned to the 1.19 Mev level. The quadrupole content of several gamma transitions is given. (auth)

2883 EVIDENCE FOR SEQUENTIAL TWO-BODY DECAY IN THE $C^{12}(d;p,n)C^{12}$ REACTION. A. E. Pitts, J. D. Bronson, T. A. Belote, and G. C. Phillips (Rice Univ., Houston, Tex.). Nucl. Phys., 48: 75-82(Sept. 1963). (TID-18785)

The $C^{12}(d,pn)$ reaction was studied using a high resolution 180° magnetic spectrometer for deuteron energies of 4.66, 4.90, and 5.46 Mev. No evidence was found for the existence of a density of states cusp near the neutron threshold similar to that seen in the $Be^9(p,p'n)Be^8$ reaction studied by Spencer et al. However, broad proton groups were observed at energies that correspond to the two-body sequential decay $C^{12} + d \rightarrow N^{14*} \rightarrow N^{13*} + n \rightarrow C^{12} + n + p$. Two excited states in N^{13} involved in this were the known 3.51- and 3.56-Mev states. The proton groups show broadening and energy shifting due to the motion of the intermediate N^{13} nucleus. Theoretical line shapes were calculated to compare with these data. The groups occur at proton energies of approximately 1.01, 1.04, and 1.08 Mev, with each broad group possessing a doublet structure with approximate widths at half height of 60, 50, and 90 kev corresponding to the deuteron bombarding energies of 4.66, 4.90, and 5.46 Mev respectively. No evidence for states at 5.51 and 6.10 Mev in C^{13} was observed. (auth)

2884 A STUDY OF THE $Li^6(\alpha,n)B^9$ AND $Li^7(\alpha,n)B^{10}$ REACTIONS. M. K. Mehta, W. E. Hunt, H. S. Plendl, and R. H. Davis (Florida State Univ., Tallahassee). Nucl. Phys., 48: 90-6(Sept. 1963).

The neutron yields from the $Li^6(\alpha,n)B^9$ and $Li^7(\alpha,n)B^{10}$ reactions were measured as a function of alpha particle bombarding energy from threshold to 15 Mev. The observed $Li^6(\alpha,n)B^9$ reaction threshold energy is 6.623 ± 0.020 Mev. Angular distributions of the emitted neutrons were measured at bombarding energies of 8.0, 10.0, 12.0, and 14.0 Mev and a spherical Bessel function squared fits to the data is presented. The excitation curve for the Li^7 target shows prominent resonances in contrast with the curve for the Li^6 target that increases monotonically with energy. The $Li^7(\alpha,n)B^{10}$ threshold energy determined in this experiment is 4.380 ± 0.020 Mev. (auth)

2885 NUCLEAR TRANSITION PROPERTIES AND ATOMIC LEVEL WIDTHS IN Sm^{151}. J. S. Geiger, R. L. Graham, and Janet S. Merritt (Atomic Energy of Canada Ltd., Chalk River, Ont.). Nucl. Phys., 48: 97-110(Sept. 1963).

Internal conversion electron lines in Sm^{151} resulting from Pm^{151} decay were studied in an iron-free double focusing spectrometer at an instrumental resolution setting of 0.1% in momentum. The use of post acceleration techniques made possible the study of the shapes and relative intensities of the M subshell conversion lines of the low energy transition feeding the ground state. The transition energy is found to be 4.821 ± 0.003 kev. The relative M subshell conversion line intensities indicate that the transition multipolarity is dominantly M1 with a very small admixture of E2. From a detailed analysis of the shapes of the internal conversion electron lines the natural widths of the atomic levels in Sm characterized by a K, and M_I, and M_{II}, and an M_{III} electron vacancy are found to be 17 ± 3, 14 ± 3, 4.7 ± 1, and 7.7 ± 1.5 ev, respectively. These widths are compared with those of other atoms (Z ≥ 47) for which M level widths are presently available. (auth)

2886 PROBLEMS AND RESULTS IN THEORETICAL AND EXPERIMENTAL INVESTIGATIONS OF THE ϵ/β^+ RATIO. D. Berényi (Inst. of Nuclear Research, Hungarian Academy of Sciences, Debrecen). Nucl. Phys., 48: 121-8 (Sept. 1963).

The present state of the theory and the experiment concerning the electron capture to positron emission ratio is given. The experimental methods and procedures are also reviewed. Possible application of the determination of the ratio and some open problems in connection with it are discussed especially in the case of forbidden transitions. (auth)

2887 THE $Ca^{40}(d,\alpha)K^{38}$ REACTION AND THE NUCLEAR STRUCTURE OF K^{38}. Joachim Jaenecke (Univ. of Michigan, Ann Arbor). Nucl. Phys., 48: 129-51 (Sept. 1963).

Natural Ca targets were bombarded with 7.7-Mev deuterons. Magnetic analysis was used to obtain α-particle spectra at angles of 50, 70, and 90°. About 35 levels in K^{38} were found up to an excitation energy of 4.8 Mev. There are the following low-lying states: (E_{exc}, J^π, T) = (0.00-Mev, 3^+, 0); (0.12-Mev, 0^+, 1); (0.43-Mev, 1^+, 0); (1.69-Mev, 1^+, 0); (2.41-Mev, 2^+, 1). They are in agree-

ment with recent intermediate coupling shell model calculations. Most of the levels above 2.5 Mev result from configurations with one or more nucleons raised into the $f_{\frac{5}{2}}$ shell. The nuclear temperature derived from an Ericson plot is 1.05 ± 0.15 Mev. Angular distributions for the low excited states were measured from 10 to 165°. The angular distributions and the total cross section show the effect of the $\Delta T = 0$ isobaric spin selection rule that inhibits direct interaction leading to T = 1 final states. Compound nucleus transitions to the T = 1 states take place, however, because of isobaric spin mixing in the intermediate nucleus, and the selection rule seems to be completely violated. The total cross sections are in agreement with the theory of Hauser and Feshbach. This theory also makes it possible to estimate the compound nucleus contributions for the transitions leading to T = 0 states. About $\frac{2}{3}$ of the total cross section for these transitions are due to direct interaction, which produces a pronounced structure of the angular distributions in the forward and backward hemisphere. The significance of this structure in terms of the various direct interaction modes is discussed. (auth)

2888 ELASTIC SCATTERING OF 14 Mev NEUTRONS FROM NICKEL. R. W. Bauer, J. D. Anderson, and L. J. Christensen (Univ. of California, Livermore). Nucl. Phys., 48: 152-8(Sept. 1963). (UCRL-7248)

The differential cross section for elastic scattering of 14-Mev neutrons from nickel was measured in the angular range from 16 to 163°. Particular emphasis was placed on the investigation of large-angle scattering where definite deviations from optical model predictions were reported previously in the proton elastic scattering process. The results are in good agreement with the optical model calculations by Bjorklund and Fernbach, suggesting that the deviations in the charged-particle data are not due to shell effects, as anticipated, but probably to compound-nucleus elastic scattering. (auth)

2889 THE K-CONVERSION COEFFICIENT OF THE 412 kev E2 TRANSITION IN ^{198}Hg. W. H. G. Lewin, B. Van Nooijen, C. W. E. Van Eijk, and A. H. Wapstra (Laboratorium voor Technische Fysika, Delft, Holland). Nucl. Phys., 48: 159-68(Sept. 1963).

The K-conversion coefficient of the 412-kev E2 transition in Hg^{198} was determined by K-conversion electron-beta coincidence measurements on Au^{198}. The result is $\alpha_K = (303.5 \pm 4.5) \times 10^{-4}$ or $(298.5 \pm 4.5) \times 10^{-4}$ depending on the adopted experimental shape factor for the 962-kev negaton distribution. Both results are in excellent agreement with the theoretical value of 302×10^{-4} computed by Rose and by Sliv and Band. (auth)

2890 TOTAL NEUTRON CROSS SECTIONS OF Na, K, AND Ca FROM 0.9 Mev TO 2.1 Mev. F. J. Vaughn, W. L. Imhof, and R. G. Johnson (Lockheed Missiles and Space Co., Palo Alto, Calif.). Nucl. Sci. Eng., 17: 325-8(Nov. 1963).

The total neutron cross sections of sodium and potassium were measured for neutron energies from 0.9 to 1.7 Mev at intervals of 5 kev, with an energy resolution of about 5 kev. Total cross sections of sodium, potassium, and calcium were measured at intervals of 50 kev from 1.25 to 2.1 Mev, using an energy resolution of about 65 to 75 kev. A neutron time-of-flight method was used in both sets of measurements. (auth)

2891 NEUTRON CROSS SECTION MEASUREMENTS ON FISSION PRODUCT SAMARIUM AND IODINE. N. J. Pattenden (Oak Ridge National Lab., Tenn.). Nucl. Sci. Eng., 17: 371-80(Nov. 1963).

The ORNL chopper was used to measure the neutron total cross sections of samples of fission product samarium and iodine in the thermal and resonance energy regions. At 2200 meters/sec, the total cross section of Sm^{151} was found to be (15000 ± 1800) barns, and the absorption cross section of I^{129} (28.0 ± 2) barns. The variation of cross section of Sm^{151} with energy in the thermal region was found to be strongly affected by a bound level, but in the case of I^{129} the absorption cross section could be described by a 1/v dependence. In the higher energy region, resonance parameters were obtained for Sm^{151}, I^{127}, and I^{129} by area analysis of the observed transmission dips. In addition, a shape analysis method was used for the lower energy resonances in Sm^{151}. Values for the level spacings, strength functions (per spin state), and resonance absorption integrals are tabulated. (P.C.H.)

2892 MEASUREMENT OF THE NEUTRON TOTAL CROSS SECTION OF U^{233} FROM 0.07 TO 10,000 ev. N. J. Pattenden and J. A. Harvey (Oak Ridge National Lab., Tenn.). Nucl. Sci. Eng., 17: 404-10(Nov. 1963).

The neutron total cross section of U^{233} was measured from 0.07 to 10,000 ev, using the ORNL fast chopper time-of-flight neutron spectrometer. Below 30 ev the neutron energy resolution varied from 0.7 to 1.5% and above 30 ev it was 60 nanosec/meter. A description is given of the measurements, the samples, and some of the errors in the measurements. The errors on the total cross section data are estimated to be from ±0.6 to 1.1% below 1 ev, from 1.1 to 2.5% between 1 and 100 ev, and from 1.5 to 5.5% above 100 ev. (auth)

2893 Li(t,n)Be THICK TARGET YIELDS. Nelson Jarmie and B. C. Diven (Los Alamos Scientific Lab., N. Mex.). Nucl. Sci. Eng., 17: 433-4(Nov. 1963). (LADC-5789)

Absolute thick target yields, in terms of neutrons per steradian per triton, of the $Li^6(t,n)Be^8$ and $Li^7(t,n)Be^9$ reactions are presented. An angular distribution for 2.60-Mev tritons and an excitation function at 0° for tritons in the range 0.80 to 2.60 Mev are given. The Li^7 yields are generally about three times larger than the Li^6 yields. Some details about the neutron spectra are presented. (auth)

2894 ORNL TRANSURANIUM PROGRAM. THE PRODUCTION OF TRANSURANIUM ELEMENTS. D. E. Ferguson. Nucl. Sci. Eng., 17: 435-7(Nov. 1963).

A brief history of the transuranium elements is given. The 90 known isotopes of the transuranium elements are arranged as a chart and properties of the isotopes are tabulated. (P.C.H.)

2895 PRODUCTION OF THE TRANSURANIUM ELEMENTS. W. D. Burch, E. D. Arnold, and A. Chetham-Strode (Oak Ridge National Lab., Tenn.). Nucl. Sci. Eng., 17: 438-42(Nov. 1963).

Gram quantities of many of the transuranium elements through californium-252 will be produced for research purposes in a production program centered at Oak Ridge National Laboratory. Plutonium-242 produced in the Savannah River production reactors will be transmuted to various higher actinide isotopes in the High Flux Isotope Reactor (thermal flux—3×10^{15} neutrons/cm^2-sec) and recovered in the adjoining Transuranium Processing Plant. Calculations that optimized the production scheme are presented. The intermediate goal of the program, production of one gram of Cf^{252}, should be accomplished by 1968. (auth)

2896 SHAPE OF BETA SPECTRA OF ONCE-FORBIDDEN TRANSITIONS IN THE DECAYS OF ^{170}Tm, ^{186}Re AND ^{188}Re. E. Bashandy and M. S. El-Nesr (Atomic Energy Establishment, Cairo). Nuovo Cimento (10), 29: 1169-74(Sept. 1, 1963).

The spectra of the $1^- \rightarrow 2^+$ β groups in the decays of Tm^{170}, Re^{186} and Re^{188} were investigated using the β-electron coincidence technique. It was found that these β groups have long comparative half-lives and allowed shapes. On the assumption that the ξ-approximation in the β-γ directional correlation should be valid when the β spectrum has an allowed shape, it is proved that the 884 and 937-kev β groups in the decays of Tm^{170} and Re^{186}, respectively, are first forbidden transitions but have allowed shape. (auth)

2897 A METHOD TO DETERMINE THE LIFE-TIME OF A NUCLEAR STATE BY MEASURING THE K-SHELL IONIZATION PROBABILITY. G. Ciocchetti (Università, Turin and Istituto Nazionale di Fisica Nucleare, Turin), A. Molinari, and R. Malvano. Nuovo Cimento (10), 29: 1262-74(Sept. 16, 1963).

The K-shell ionization probability, due to nuclear reactions like (n,n), (n,p), (p,p) ... is calculated using a first-order perturbation method. It is found that such a probability depends strongly on the life time of the intermediate nuclear state, and on the angle between the incoming and the outgoing particles. Graphs are presented to illustrate the general formulas and an evaluation of the experimental feasibility of the method is given for the particular case of the neutron elastic scattering. (auth)

2898 THE EXCITATION OF COLLECTIVE STATES BY INELASTIC SCATTERING. THE EXTENDED OPTICAL MODEL. B. Buck (Oak Ridge National Lab., Tenn.); A. P. Stamp, and P. E. Hodgson. Phil. Mag. (8), 8: 1805-26(Nov. 1963).

The formalism required to calculate elastic and inelastic nuclear scattering with excitation of collective vibrational and rotational states of the target nucleus is summarized. The methematical techniques used to solve the resulting coupled differential equations with an electronic computer are given together with the necessary checking procedures. The results of some typical calculations are presented to show the dependence of the elastic and inelastic cross sections on some of the parameters of the model. (auth)

2899 ON THE THREE-DIMENSIONAL EVALUATION OF FOUR PARTICLE REACTIONS. K. Hehl and C. Riedel (Zentralinstitut für Kernphysik, Rossendorf, Ger.). Phys. Letters, 7: 38-40(Oct. 15, 1963). (In German)

The four-particle reaction mechanism is discussed. The surface appearance of the particles during direct interaction is described in a center-of-mass system. (R.E.U.)

2900 EXPERIMENTAL EVIDENCE OF AN ERROR IN THE CONVERSION ELECTRON-GAMMA CORRELATION THEORY: LEVEL SPINS IN I^{127}. J. S. Geiger (Atomic Energy of Canada Ltd., Chalk River, Ont.). Phys. Letters, 7: 48-51(Oct. 15, 1963).

The spins of states in I^{127} populated by the K-capture decay of Xe^{127} were determined. The relative conversion line intensities of the I^{127} transitions and the gamma-gamma, conversion electron-gamma, and gamma-conversion electron angular correlations for the 172.1–202.8 kev cascade were measured. (R.E.U.)

2901 THE LONGITUDINAL POLARIZATION OF BETA-ELECTRONS FROM Cd^{115m}. V. G. Kulkarni, C. V. Panat, and B. V. Thosar (Tata Inst. of Fundamental Research, Bombay). Phys. Letters, 7: 52(Oct. 15, 1963).

The degree of polarization was measured at 128 kev by Mott scattering. It was found that beta electrons from Cd^{115m} show a deviation of 15% from the $-(v/c)$ rule for which P^{32} shows no deviation. An accidental cancellation of nuclear matrix elements is suggested. (R.E.U.)

2902 SECOND FORBIDDEN BETA DECAY AND THE GROUND STATE TRANSITION OF Cl^{36}. P. Lipnik and J. W. Sunier (Laboratoire de Physique des Hautes Energies, Zurich). Phys. Letters, 7: 53-4(Oct. 15, 1963).

Experimental evidence is given to show that the ratio of the nuclear matrix elements of the vector part of the weak interaction is independent of the nuclear potential. (R.E.U.)

2903 AVERAGE COMPOUND NUCLEUS CROSS SECTIONS IN THE CONTINUUM. G. R. Satchler (Oak Ridge National Lab., Tenn.). Phys. Letters, 7: 55-6(Oct. 15, 1963).

Use is made of the unitarity of the collision matrix to define generalized transmission coefficients and to clarify the relation between compound nucleus formation and various direct interaction models. (R.E.U.)

2904 THE STATE AT 1576 kev IN Sm^{152}. K. Maack Bisgard, K. Bonde Nielsen, and J. Sodemann (Univ. of Aarhus, Denmark). Phys. Letters, 7: 57-60(Oct. 15, 1963).

The angular correlation between photons of about 1210 kev and the 244K conversion electrons was determined. The high-energy photons were also recorded in coincidence with the 244–kev photons. The multipolarity of the 1210- and 1300-kev transitions was determined. (R.E.U.)

2905 DETERMINATION OF d-WAVE NEUTRON STRENGTH FUNCTIONS FROM INELASTIC NEUTRON SCATTERING TO ISOMERIC STATES. E. W. Vogt (Chalk River Nuclear Labs., Ont.). Phys. Letters, 7: 61-4(Oct. 15, 1963).

It is shown that an accurate estimate of the d-wave neutron strength function can be obtained for data on inelastic neutron scattering to the isomeric states of a large number of nuclei. The d-wave strength function was determined for In^{115}. (R.E.U.)

2906 INVESTIGATION OF ISOBARIC-SPIN CONSERVATION IN THE $O^{16}(d,\alpha)N^{14}$ REACTION USING A HIGH RESOLUTION SEMICONDUCTOR E-(dE/dx) SYSTEM. J. Cerny, R. H. Pehl, E. Rivet, and B. G. Harvey (Univ. of Calif., Berkeley). Phys. Letters, 7: 67-9(Oct. 15, 1963). (UCRL-10911)

An upper limit for the ratio of the cross section for the $O^{16}(d,\alpha)N^{14*}$ (2.31 Mev) O^+, T = 1 transition to the cross section for the $O^{16}(d,\alpha)N^{14}$ ground state transition, with 24-Mev incident deuterons, was found to be 0.7 ± 0.6%. This result is discussed in terms of the possible mechanism for populating the 2.31-Mev state, with emphasis on the variation of i-spin impurity of states of a compound nucleus with increasing excitation. (R.E.U.)

2907 DIPROTON AND THE $He^3(d,t)He^2$ REACTION. O. M. Bilaniuk and R. J. Slobodrian (Comisión Nacional de Energía Atómica, Buenos Aires). Phys. Letters, 7: 77-9 (Oct. 15, 1963).

The absolute differential cross section for $He^3(d,t)He^2$ at deuteron energy of 28 Mev was measured after the discrete triton group, corresponding to this process, was found. (R.E.U.)

2908 β–γ DIRECTIONAL CORRELATIONS OF Ga^{72}, La^{140} AND Rb^{86}. J. E. Alberghini and R. M. Steffen (Purdue Univ., Lafayette, Ind.). Phys. Letters, 7: 85-6 (Oct. 15, 1963).

Accurate β–γ directional correlation data on β-transitions that show deviations from a nonallowed shape are used to determine the nuclear matrix elements that contribute to a nonunique β-decay. Anisotropy coefficients are found. (R.E.U.)

2909 MAGNETIC HYPERFINE INTERACTION OF Cr^{53}. W. J. Childs, L. S. Goodman, and D. von Ehrenstein

(Argonne National Lab., Ill.). Phys. Rev., 132: 2128-35 (Dec. 1, 1963).

The hfs of Cr^{53} was investigated by the atomic-beam magnetic-resonance technique. The atoms were detected with an electron-bombardment universal detector. Novel counting techniques made possible observation of resonances for which the signal-to-background ratio was 0.0002. The magnetic-dipole hyperfine-interaction constant was measured to be a = ±(82.5985 ± 0.0015) Mc/sec and the electric-quadrupole hyperfine-interaction constant was found to be consistent with b = 0. These results are compared with the theory. From the measured value of a, the average magnetic field at the nucleus is calculated to be 1.03×10^6 G within about 1%. (auth)

2910 ELASTIC AND INELASTIC SCATTERING OF PROTONS BY CARBON-12 FOR PROTON ENERGIES BETWEEN 18 AND 30 Mev. J. Kirk Dickens, David A. Haner, and Charles N. Waddell (Univ. of Southern California, Los Angeles). Phys. Rev., 132: 2159-68(Dec. 1, 1963).

Differential cross sections for elastic scattering of protons by C^{12} were measured for incident proton energies between 18 and 30 Mev. Angular distributions were obtained for proton energies of 20.0, 21.6, 24.1, 26.1, and 27.8 Mev. The elastic differential cross section as a function of energy for center-of-mass angles of 46.7, 60.6, 135.0, and 145.0° was investigated for incident energies between 17.6 and 30.4 Mev. Absolute angular distributions and integrated partial cross sections for proton scattering leading to the excitation of the 4.4-, 7.7-, 9.6-, and 12.7-Mev levels in C^{12} are reported. The angular distributions of the elastically scattered protons are strongly energy-dependent over the studied energy interval. The inelastic angular distributions do not exhibit such a marked energy dependence and are peaked forward for all levels studied. The angular distributions of protons inelastically scattered from the 4.4-Mev level are compared with the predictions of the zero-range, plane-wave Born-approximation direct-interaction theory. (auth)

2911 POSITRON RADIOACTIVITIES OF O^{14}, Ne^{18}, Si^{26}, AND S^{30}. G. Frick, A. Gallmann, D. E. Alburger, D. H. Wilkinson, and J. P. Coffin (Institut de Recherches Nucléaires, Strasbourg). Phys. Rev., 132: 2169-84(Dec. 1, 1963).

A Siegbahn-Slätis intermediate-image spectrometer was used to measure the positron spectra of the isotopes O^{14}, Ne^{18}, Si^{26}, and S^{30} produced by a He^3 beam from a 5.5-Mev Van de Graaff accelerator. O^{14} was formed in the $C^{12}(He^3,n)O^{14}$ reaction and it emits a positron group of E_{max} = (4.085 ± 0.030) Mev to the ground state of N^{14} and another group having E_{max} = (1.821 ± 0.007) Mev to the 2.3-Mev level. The branching ratios are (0.65 ± 0.05)% (log ft = 7.23 ± 0.04) and (99.35 ± 0.05)% (log ft = 3.49 ± 0.01), respectively. The measured half life of O^{14} is 71.3 ± 0.1 sec. Ne^{18} was formed in the $O^{16}(He^3,n)Ne^{18}$ reaction and E_{max} = (3.416 ± 0.009) Mev to the ground state of F^{18}, and $T_{1/2}$ = 1.47 ± 0.10 sec. From a study of the beta and gamma rays of Ne^{18} by means of scintillation detectors a second positron branch feeding the 1.04-Mev level of F^{18} is found. The branching ratios obtained from these measurements are (91 ± 3)% (log ft = 3.02 ± 0.02) to the ground state and (9 ± 3)% (log ft = 3.47 ± 0.13) to the 1.04-Mev level. The isotope Si^{26}, produced by the $Mg^{24}(He^3,n)Si^{26}$ reaction, decays with two branches to Al^{26}. The more energetic branch feeds the 0.229-Mev isomeric state of Al^{26} and has E_{max} = 3.828 ± 0.013 Mev from a magnetic spectrometer measurement, while the second branch is masked by other positron activities. $T_{1/2}$ = 2.1 ± 0.1 sec for Si^{26}. The second positron branch of Si^{26} has been confirmed by observation of (0.820 ± 0.010) Mev gamma rays in coincidence with positrons. Branching ratios of Si^{26}, measured with scintillation detectors, are (66^{+1}_{-4})% (log ft = $3.52^{+0.04}_{-0.02}$) for the branch to the 0.229-Mev level of Al^{26} and (34^{+4}_{-1})% (log ft = $3.36^{+0.02}_{-0.03}$) for the branch to the 1.059-Mev level. S^{30} was produced by the $Si^{28}(He^3,n)S^{30}$ reaction and it decays with a half life of 1.4 ± 0.1 sec and with positron branches of E_{max} = (5.085 ± 0.026) Mev to the ground state of P^{30} and E_{max} = (4.422 ± 0.022) Mev to the 0.684-Mev level. The branching ratios, obtained by analyzing the positron spectrum, are (20 ± 1)% (log ft = 4.39 ± 0.03) and (80^{+1}_{-15})% (log ft = $3.49^{+0.09}_{-0.03}$) respectively. Positron-gamma coincidence measurements confirm the decay scheme. Some comments are made on the abnormal value of the matrix element in the decay of O^{14} to the ground state of N^{14} and the results on the pure Fermi transitions observed in each of the isotopes are discussed. (auth)

2912 MOMENTS OF INERTIA AND THE SHELL MODEL. C. A. Levinson (Weizmann Inst. of Science, Rehovoth, Israel). Phys. Rev., 132: 2184-8(Dec. 1, 1963).

The variational formula of Skyrme for the moment of inertia is analyzed in some detail. The errors in this formula are studied and an upper bound is given. It is found that in the case of the shell model this approach is quite accurate and allows use of general Hamiltonians. (auth)

2913 VARIATIONAL SHELL-MODEL METHODS FOR DEFORMED ORBITALS. I. Kelson (Weizmann Inst. of Science, Rehovoth, Israel). Phys. Rev., 132: 2189-93 (Dec. 1, 1963).

A single-particle representation of deformed orbitals in the s-d shell is obtained by using variational self-consistent methods. The two-body Rosenfeld potential is taken as the effective interaction. The dependence of the single-particle Hamiltonian on the force parameters, as well as its dependence on the number of nucleons, is investigated. The results are compared with the deformed harmonic-oscillator model, discussed by Mottelson and Nilsson. (auth)

2914 MEASURABILITY OF NUCLEAR ELECTRIC DIPOLE MOMENTS. L. I. Schiff (Stanford Univ., Calif.). Phys. Rev., 132: 2194-2200(Dec. 1, 1963).

The possibility of measuring a very small nuclear electric dipole moment is explored by calculating the interaction of this moment with an external electric field. It is shown that for a quantum system of point-charged, electric dipoles in an external electrostatic potential of arbitrary form, there is complete shielding; i.e., there is no term in the interaction energy that is of first order in the electric dipole moments, regardless of the magnitude of the external potential. This is true even if the particles are of finite size, provided that the charge and dipole moment of each have the same spatial distribution. Relativistic and second-order effects are uninterestingly small. There is, however, a first-order interaction if the charge and moment distributions are different, and also for a point electric dipole if it also carries a magnetic dipole moment. Explicit calculations of both effects are given for hydrogen and helium atoms. It is found that the effective electric field at a He^3 nucleus arising from the magnetic dipole effect is about a hundred times that arising from the finite size effect, and is roughly 10^{-7} times the external electric field. (auth)

2915 ELASTIC SCATTERING OF 17-Mev PROTONS BY HEAVY NUCLEI. G. Schrank and R. E. Pollock (Princeton Univ., N. J.). Phys. Rev., 132: 2200-3(Dec. 1, 1963). (PUC-1963-108)

Absolute differential cross sections for elastic scattering of protons from Ta^{181}, W, Pb^{208}, and Bi^{209} were measured at a center-of-mass energy of 17.00 ± 0.05 Mev at angular intervals of five degrees ranging from 20 to 170°. The estimated relative standard deviation of each point is 3% while the absolute cross-section scale is uncertain by 5% for Pb and Bi and by 10% for Ta and W. The scattered protons were detected by a NaI(Tl) scintillation counter with an overall energy resolution of 2.5%. Consequently, while all inelastically scattered protons are rejected for Bi and Pb, a small contribution of inelastic protons from the lowest levels in Ta and the tungsten isotopes is included in the measured cross sections. For Ta and W the diffraction pattern appears damped at backward angles relative to the heavier two targets to a greater extent than may be attributed to the effects of an inelastic scattering component. (auth)

2916 NUCLEAR SUPERFLUIDITY AND STATISTICAL EFFECTS IN NUCLEAR FISSION. James J. Griffin (Los Alamos Scientific Lab., N. Mex.). Phys. Rev., 132: 2204-11(Dec. 1, 1963). (LADC-5854)

The Bardeen, Cooper, Schrieffer (BCS) formalism is applied to a calculation of the mean-square projection K_0^2 of the angular momentum along the symmetry axis of an excited deformed nucleus. The results are compared with empirical values obtained from analysis of recent data on fission-fragment angular distributions. The comparison corroborates qualitatively the validity of this application of the BCS formalism. Quantitative optimization of the fit to experiment yields the result that the energy gap for a nucleus deformed to the fission-barrier shape is about twice as large as the same quantity at the stable shape. Implications of this result for odd-even effects in nuclear fission are discussed. (auth)

2917 SCATTERING OF PROTONS FROM C^{12} IN THE ENERGY RANGE OF 5-6 Mev. N. Nikolic, L. J. Lidofsky, and T. H. Kruse (Columbia Univ., New York). Phys. Rev., 132: 2212-24(Dec. 1, 1963).

Excitation functions and angular distributions were obtained in the bombarding energy range 5 to 6 Mev for the elastic and inelastic (4.43-Mev state) scattering of protons from C^{12}, for the 4.43-Mev gamma rays. Three resonances were observed, at bombarding energies of 5.38, 5.68, and 5.90 Mev (excitation energies in N^{13} of 6.91, 7.19, and 7.40 Mev). The corresponding center-of-mass widths are 115 ± 5, 9 ± 0.5, and 75 ± 5 kev, respectively. The center-of-mass elastic widths are 4.6, 0.36, and 6.9 kev, respectively. Analysis of the interference characteristics of the elastic scattering cross sections, together with analysis of the various angular distributions and applications of the Wigner limit rule, leads to the following assignments of quantum numbers: for the 5.38-Mev (bombarding energy) resonance, $^3/_2{}^+$; for the 5.68-Mev resonance, very probably $^7/_2{}^+$; for the 5.90-Mev resonance, $^5/_2{}^-$. (auth)

2918 USE OF EFFECTIVE INTERACTIONS IN THE ANALYSIS OF DEFORMED NUCLEI. Issachar Unna (Weizmann Inst. of Science, Rehovoth, Israel). Phys. Rev., 132: 2225-36(Dec. 1, 1963).

Energy levels in O^{17}, F^{18}, F^{19}, and Ne^{20} are calculated. The wave functions for the various states are generated from intrinsic deformed potential wave functions. The wave functions for which best agreement is obtained are similar to those obtained by Redlich. No a priori assumptions are made on the form of the two-body forces. These are adjusted to give best fit with experiment. The agreement obtained between the calculated and experimental energy levels is good. (auth)

2919 RECOIL ENERGY SPECTRUM OF THE SODIUM IONS FOLLOWING THE β^- DECAY OF Ne^{23}. Thomas A. Carlson (Oak Ridge National Lab., Tenn.). Phys. Rev., 132: 2239-42(Dec. 1, 1963).

Following the beta decay of Ne^{23}, the sodium ions have a recoil energy distribution which is dependent on the nature of the decay. A precise measurement was made of the recoil spectrum from 100 to 500 ev. From these data the electron-neutrino angular correlation coefficient α was determined to be -0.33 ± 0.03, in good agreement with V-A interaction. The quoted error includes an uncertainty of only 2% due solely to the recoil measurements. The principal uncertainty in α arises from the errors quoted by Penning and Schmidt for their measurements of the β^--ray intensities to the ground and first excited states. If it is assumed that V-A interaction is valid and hence $\alpha = {}^1/_3$, the β^--ray intensities to the ground and first excited states of Na^{23} may be calculated from the recoil data. Such calculations were made and the results are, respectively, (67 ± 1)% and (32 ± 1)%. From the end point of the recoil spectrum, the decay energy to the ground state was determined to be 4.383 ± 0.008 Mev. (auth)

2920 DIRECT ELECTRODISINTEGRATION AND PHOTOEFFECT OF NUCLEI. J. M. Eisenberg (Univ. of Virginia, Charlottesville). Phys. Rev., 132: 2243-50 (Dec. 1, 1963).

A method is presented for extracting from the differential cross section for the (e,Ne′) reaction the differential cross section for the corresponding (γ,N) reaction. Here N refers to a nuclear particle of spin 0 or ½. This method is developed for arbitrary multipoles, thus extending the result given by Bosco and Fubini for E1 transitions. A model is used in which the ejected nuclear particle moves initially in a potential well provided by a nuclear core, and has a definite total angular momentum. The electrodisintegration process is considered to take place in such a fashion that the nuclear core is in the same state initially and finally. The electron is treated in Born approximation. In addition to the results for arbitrary multipoles, the interference for the E1 term with E0, M1, and E2 terms is studied in detail. Both the differential cross section in outgoing electron and nuclear particle directions, as well as that pertaining to the angular distribution of the latter particle alone, are given. The case of a pure M1 transition is considered. (auth)

2921 NEUTRON PHOTOPRODUCTION CROSS SECTIONS OF SILICON, PHOSPHORUS, AND SULFUR. L. N. Bolen and W. D. Whitehead (Univ. of Virginia, Charlottesville). Phys. Rev., 132: 2251-4(Dec. 1, 1963).

The absolute (γ,n) cross sections of natural silicon, phosphorus, and sulfur were measured using the bremsstrahlung from a 70-Mev synchrotron. Yield points were taken at 0.5-Mev intervals from 12 to 30 Mev in each case. The absolute measurements were made utilizing a Halpern-type detector, a modified version of an NBS ionization chamber, and a calibrated Ra–Be neutron source. A minimum of 20 runs was made for each element, with less than 1% standard deviation in the yield points contributed by the major isotope. The data were analyzed from 12 to 30 Mev by the Leiss Penfold technique using 2 interlacing 1-Mev bin widths and also using 0.5-Mev bin widths. Our results show that each cross section is composed of several discrete resonances, with at least 4 resonances resolved in each cross section. (auth)

2922 SPECTRA OF Ti^{51}, Cr^{53}, AND Fe^{55} AND THE UNIFIED MODEL. K. Ramavataram (Univ. of Michigan, Ann Arbor). Phys. Rev., 132: 2255-61(Dec. 1, 1963).

The spectrum and level properties of Ti^{51} were investi-

gated by the reaction $Ti^{50}(d,p)Ti^{51}$ using a high-resolution magnetic analysis system. The four nuclei Ca^{49}, Ti^{51}, Cr^{53}, and Fe^{55} have an odd neutron outside a closed $f_{\frac{7}{2}}$ neutron shell. The spectrum of Ca^{49} as observed in a (d,p) reaction on Ca^{48} is single-particle-like. In the other nuclei, the neutron single-particle states are fragmented to varying degrees. An attempt was made to study the information available for Ti^{51}, Cr^{53}, and Fe^{55} on the basis of the unified model by coupling the $p_{\frac{3}{2}}$, $p_{\frac{1}{2}}$, and $f_{\frac{7}{2}}$ shell model states to a quadrupole vibrational core. Core states of up to three phonons were included in the calculation. Reasonable agreement was obtained with the excitations and transition strengths of the low-lying levels of the three nuclei as observed in (d,p) reactions on the corresponding even-even nuclei. In the case of Cr^{53} which is stable, additional experimental information is available, viz., the ground state magnetic moment, the static quadrupole moment and the lifetime of the 2.32-Mev level. Using the model wavefunctions obtained for Cr^{53}, these quantities were computed and found to be in poor agreement with the experimentally observed values. (auth)

2923 OPTICAL MODEL IN THE INTERIOR OF THE NUCLEUS. [PART] II. K. A. Amos and I. E. McCarthy (Univ. of Adelaide and Univ. of California, Davis). Phys. Rev., 132: 2261-9(Dec. 1, 1963).

Factors which influence the relative contribution of the interior and the surface of the nucleus to matrix elements for direct interactions involving nucleons in the entrance and exit channels are studied quantitatively. Purely optical-model effects causing localization of the reaction are phase averaging, which tends to deemphasize the interior at all energies, and focusing which emphasizes the interior at low energies and the surface at higher energies. It is shown that phase averaging does not make the central contribution negligible at any energy. The foci in the optical-model wave functions have large effects on angular distributions. Density dependence of the two-body force for reactions which proceed by a two-body collision mechanism can be identified from angular distributions and from the energy dependence of backward cross sections which are particularly sensitive to the foci. (auth)

2924 LIFETIME, SPIN, AND PARITY OF THE FIRST EXCITED STATE OF B^{12}. E. K. Warburton and L. F. Chase, Jr., (Brookhaven National Lab., Upton, N. Y.). Phys. Rev., 132: 2273-7(Dec. 1, 1963). (BNL-7190)

The mean lifetime of the first excited state of B^{12} at 0.95 Mev was measured by the Doppler shift attenuation technique using the $B^{11}(d,p)B^{12}$ reaction to populate the state. The result is $\tau = (3.4 \pm 1) \times 10^{-13}$ sec. Sum rules are invoked to show that the deexcitation of this state to the $J^\pi = 1^+$ B^{12} ground state cannot be predominantly E2 so that the spin-parity of the B^{12} first excited state cannot be 3^+. The angular distribution of the ground-state decay from this level was measured at a deuteron energy of 0.8 Mev. The result rules out a zero-spin assignment. It is concluded that the available experimental evidence indicates 2^+ for the spin-parity of the B^{12} first excited state. (auth)

2925 ELECTRON-NEUTRINO ANGULAR CORRELATION IN THE DECAY OF He^6. Joseph B. Vise and Brice M. Rustad (Columbia Univ., New York and Brookhaven National Lab., Upton, N. Y.). Phys. Rev., 132: 2573-81(Dec. 15, 1963). (BNL-7163)

The energy spectra of recoil lithium ions in coincidence with beta particles of selected energy were measured for the beta decay of He^6. The beta-particle energy was determined with a well-type beta scintillation detector; and the energy and charge of the recoil ions were measured with an electrostatic spectrometer and time-of-flight analyzer. The electron-neutrino angular-correlation coefficient determined from the observed energy distributions of recoil ions is $\lambda = -0.319 \pm 0.028$. The ratio of the tensor to axial vector coupling constants calculated from this measurement is $(|C_T|^2 + |C_T'|^2)/(|C_A|^2 + |C_A'|^2) = 0.022 \pm 0.044$. A new measurement of the He^6 beta spectrum was made with a thin-lens magnetic spectrometer, and the maximum energy is 3.508 ± 0.015 Mev. (auth)

2926 INELASTIC PROTON SCATTERING ON HOLMIUM-165 AND GADOLINIUM-156. A. Lieber and C. A. Whitten (Princeton Univ., N. J.). Phys. Rev., 132: 2582-6 (Dec. 15, 1963). (PUC-1963-111)

Elastic and inelastic scattering of 17.5-Mev protons by the low-lying rotational levels of holmium-165 and gadolinium-156 was studied using a telescopic array of solid-state detectors with a resolution of about 60 kev. Angular distributions were obtained for the ground state ($\frac{7}{2}^-$), first excited state ($\frac{9}{2}^-$), and second excited state ($\frac{11}{2}^-$) of holmium-165, and the ground state (0^+), first excited state (2^+), and second excited state (4^+) of gadolinium-156. The cross section for the first excited state of Ho^{165} is an order of magnitude below that of the ground state. The ratio of the first excited state of Ho^{165} to that of the second does not agree with the prediction given by first-order direct reaction theory. There is some evidence that the third-excited state of Gd^{156} (6^+) is weakly excited by 17.5-Mev protons. (auth)

2927 DECAY OF Y^{85} ISOMERS. I. Dostrovsky, S. Katcoff, and R. W. Stoenner (Brookhaven National Lab., Upton, N. Y.). Phys. Rev., 132: 2600-6(Dec. 15, 1963). (BNL-7181)

Two isomers of Y^{85} were identified and their half lives determined as 2.68 ± 0.05 h and 5.0 ± 0.2 h. Measurements were made by means of successive timed daughter separations and by direct observation of the decay of radiations from yttrium. Both isomers decay independently by positron emission. The 2.68-h isomer decays to the 70-min Sr^{85m} while the 5.0-h isomer decays to the 64-d Sr^{85}. No isomeric transition was observed. Positron spectra were measured with a β-ray spectrometer. The spectrum for the 2.68-h isomer has an end-point energy of 1.54 ± 0.02-Mev, and the components of the 5-h isomer have end points of 2.24 ± 0.01, 2.01 ± 0.01, and 1.1 ± 0.1 Mev. Conversion electron measurements disclosed a 503-kev transition, with a half life of 2.68 h, K conversion coefficient of 1.9×10^{-3}, and K/L ratio of ~10. The γ spectrum for the Y^{85} isomeric mixture is complex. The observed transitions are: 503 and 925 kev from the 2.68-h isomer, and 231, 700, 772, (1030), (1130), 1230, 1390, 1590, 1870, 2160, 2340, and 2750 kev from the 5.0-h isomer. Sum-coincidence spectra showed summation of the following radiations: (231−511), (503−511), (231−1390), and (772−1390) kev. Beta-gamma coincidence measurements showed that the 2.01-Mev positron group is coincident with the 231-kev γ ray and that the 1.54-Mev positron from the 2.68-h isomer is in coincidence with the 503-kev γ ray. The 5.0-h isomer of Y^{85} is 3.26 Mev above the ground level of Sr^{85} while the 2.68-h isomer is at 3.30 Mev, thus being 40 ± 30 kev higher. Spins of $\frac{9}{2}^+$ and $\frac{1}{2}^-$ were assigned to the 5.0-h and 2.68-h isomers, respectively. A partial decay scheme is presented. (auth)

2928 ELASTIC SCATTERING OF PROTONS BY Li^6. William D. Harrison and A. Bruce Whitehead (California Inst. of Tech., Pasadena). Phys. Rev., 132: 2607-13 (Dec. 15, 1963).

The differential cross section for the elastic scattering of protons by Li^6 is presented at energies from 2.4 to 12 Mev and laboratory angles from 33.8° to 160°. A resonance appears strongly at backward angles at incident proton energy of 5 Mev suggesting the existence of a level in Be^7 at approximately 10 Mev. The possibility of this level being a ^4P state in Be^7 is discussed. (auth)

2929 MAGNETIC ANALYSIS OF THE $Be^9(p,\alpha)Li^6$ REACTION. D. E. Groce and W. Whaling (California Inst. of Tech., Pasadena). Phys. Rev., 132: 2614-15(Dec. 15, 1963).

The momentum spectrum of the alpha particles from the $Be^9(p,\alpha)Li^6$ reaction was measured in a magnetic spectrometer at 30° with 10-Mev incident proton energy. The discrete alpha-particle groups observed correspond to states in Li^6 at 0-, 2.19-, 3.55-, 4.40-, and 5.32-Mev excitation energy. Higher excited states are obscured at all angles of observation by the continuous alpha spectrum from the breakup in flight of Be^8, Li^{6*}, Be^{9*}, and B^9. (auth)

2930 BETA SPECTRUM OF Ca^{47}. L. M. Langer, E. H. Spejewski, and D. E. Wortman (Indiana Univ., Bloomington). Phys. Rev., 132: 2616-20(Dec. 15, 1963).

A detailed magnetic spectrometer study was made of the shape of the beta-ray spectrum in the decay of Ca^{47}. It was definitely established that the highest energy transition does not have a once forbidden unique shape and, therefore, that a $\frac{3}{2}^+$ assignment to the ground state of Ca^{47} is not possible. The ground-state to ground-state transition of 1.979 ± 0.005 Mev is probably from a $\frac{7}{2}^-$ initial to a $\frac{7}{2}^-$ final state with an abnormally high comparative half life (log $\underline{ft}$ = 8.5) possibly resulting from distortion of the Ca^{47} nucleus. Evidence was found for a beta transition to the first excited state of Sc^{47}. This appears to be a twice forbidden transition from $\frac{7}{2}^-$ to $\frac{3}{2}^-$ with an energy of 1.486 ± 0.010 Mev and an intensity of 1.3 to 1.8%. The comparative half life for this $\Delta I = 2$, no transition is relatively short with log $\underline{ft}$ = 9.0. The beta transition to the second excited state of Sc^{47} has an energy of 0.671 ± 0.010 Mev. The relative intensity is 82.4% and log $\underline{ft}$ = 6.0. The observations are consistent with an assignment $\frac{7}{2}^-$ to $\frac{5}{2}^-$. The energies of the three gamma rays that follow the decay of Ca^{47} were measured with a NaI(Tl) detector and 400-channel analyzer. The energies were found to be 1.308 ± 0.005, 0.815 ± 0.005, and 0.493 ± 0.010 Mev. The half life for the beta decay was measured in the magnetic spectrometer and found to be 4.7 ± 0.1 days. (auth)

2931 ELASTIC SCATTERING OF DEUTERONS BY BERYLLIUM. James H. Renken (California Inst. of Tech., Pasadena). Phys. Rev., 132: 2627-31(Dec. 15, 1963).

The differential cross section for the elastic scattering of deuterons by beryllium was measured for bombarding energies from 0.4 to 1.8 Mev at the center-of-mass angles of 90°, 126°16′, and 163°30′. The ratios of the observed differential cross sections to the Rutherford cross sections were found to be slowly increasing functions of the bombarding energy. Over the energy range of the present experiment these ratios are compatible with the simple assumption that the scattering nuclei can be represented by nearly impenetrable charged spheres. Since no resonance structure was observed, these results disagree with previously published work on the elastic scattering of deuterons by beryllium in which prominent scattering anomalies were reported at E_d = 1.16 and 1.35 Mev. (auth)

2932 NUCLEAR STRUCTURE STUDIES IN THE ZINC ISOTOPES WITH STRIPPING REACTIONS. E. K. Lin and B. L. Cohen (Univ. of Pittsburgh). Phys. Rev., 132: 2632-8 (Dec. 15, 1963).

The (d,p) reactions on Zn^{64}, Zn^{66}, Zn^{67}, and Zn^{68} were studied with ~90-kev resolutions and analyzed with distorted-wave Born approximation calculations. About 20 levels from each of these reactions are identified and assigned to shell-model states. Sum rules are applied to estimate the degree of the filling of these. The results for this and locations of the centers of gravity of the shell-model levels are compared with results for isotonic nuclei, and with pairing theory. Measurements on (d,t) reactions are also included; among other things, they indicate that the 39th and 40th neutrons go predominantly into $g_{9/2}$ rather than $p_{1/2}$ states. (auth)

2933 $F^{19}(p,t)F^{17}$ AND $F^{19}(p,\alpha)O^{16}$ REACTIONS AT 22.8 Mev. H. D. Holmgren (Univ. of Maryland, College Park) and C. B. Fulmer. Phys. Rev., 132: 2644-9(Dec. 15, 1963).

The differential cross sections for the $F^{19}(p,t)F^{17}$ reactions leading to the ground state and first excited state of F^{17}, and for the ground-state α-particle group and the composite α-particle groups corresponding to the two unresolved doublets at 6 Mev (6.05 and 6.13) and at 7 Mev (6.92 and 7.12) of excitation in O^{16} from the $F^{19}(p,\alpha)O^{16}$ reaction, were measured as functions of angle at an incident energy of 22.8 Mev. Data were also obtained for higher excited-state groups from both reactions at several forward angles. The angular distributions for all groups exhibit typical oscillatory variations with angles, to the largest angles observed, 170°. The amplitude of the variations is most pronounced for the α_0 group. The total cross sections, obtained by numerical integration of the differential cross sections, are 1.84, 1.45, 0.53, 0.43, and 0.45 mb for the t_0, $t_{0.5}$, α_0, α_6, and α_7 groups, respectively. The angular distributions of the t_0, $t_{0.5}$, and α_0 groups were fitted with distorted-wave Born approximation calculations. Exchange interactions do not appear to be required in order to fit these data, although the possibility of knockout processes cannot be eliminated on the basis of the present calculations. (auth)

2934 ELECTRON CAPTURE OF At^{210}(8.3 h) TO Po^{210}. F. Schima, E. G. Funk, Jr., and J. W. Mihelich (Univ. of Notre Dame, Ind.). Phys. Rev., 132: 2650-6(Dec. 15, 1963). (TID-19152)

The electron capture decay of At^{210}(8.3 h) to excited states in Po^{210} was studied with scintillation spectrometers and coincidence and directional correlation techniques. Previously observed transitions were verified, as well as transitions of 495 and 2250 kev. No evidence for a 2600-kev transition was found. The data are consistent with a level scheme with states at 1185 kev (2^+), 1431 kev (4^+, $T_{1/2}$ = 1.8 ± 0.2 nsec), 1478 kev (6^+, $T_{1/2}$ = 38.4 ± 5.1 nsec), 2919 kev (5^-), 3035 kev (5^-), and 3680 kev. The last three levels are populated with electron capture branches with log $\underline{ft}$ values of 5.90, 6.40, and 5.90, respectively. The At^{210} ground state was determined to be approximately 3830 kev above that of Po^{210}, by comparison of the relative intensities of L capture and K capture. The transition probabilities are calculated for transitions depopulating the 1431- and 1478-kev levels using a configuration mixing model. The effects of coupling single-particle states to surface vibrations are included in the calculations. (auth)

2935 KINETIC ENERGY AND PROMPT NEUTRON DISTRIBUTIONS IN FISSION. Peter Fong (Syracuse Univ., Utica, N. Y.). Phys. Rev. Letters, 11: 375-8(Oct. 15, 1963).

The previously established facts that the kinetic energy of a fission pair as a function of the mass ratio of the two fragments shows a drastic dip in the symmetric fission re-

gion and the saw-tooth structure of the average number of prompt neutrons per fragment as a function of the fragment mass are considered. It is shown that statistical theory can explain these phenomena provided that all effects of the nuclear are taken into account. These effects include the effect on nuclear masses and deformability. Results are shown for the neutron fission of U^{235}. (C.E.S.)

2936 TOTAL RADIATION WIDTHS FOR s-WAVE AND p-WAVE NEUTRON CAPTURE IN Nb^{93}. H. E. Jackson (Argonne National Lab., Ill.). Phys. Rev. Letters, 11: 378-80(Oct. 15, 1963).

The total radiation widths for s- and p-wave resonances in Nb^{93} were investigated, and, in contrast to previous assumptions, it is shown that there is a marked difference between these quantities. (C.E.S.)

2937 ANALYSIS OF H^3 AND He^3 FORM FACTORS AND THE DETERMINATION OF THE CHARGE FORM FACTOR OF THE NEUTRON. L. I. Schiff, H. Collard, R. Hofstadter, A. Johansson, and M. R. Yearian (Stanford Univ., Calif.). Phys. Rev. Letters, 11: 387-90(Oct. 15, 1963).

Elastic scattering of high-energy electrons from H^3 and He^3 provided information on the distributions of charge densities, magnetic moment densities, and sizes of the two mirror nuclei. The form factors that describe some of the internal dynamics of nucleons in the ground state of H^3 and He^3 were analyzed. The charge form factor of the neutron was also determined. (C.E.S.)

2938 INTERMEDIATE STRUCTURE IN THE ENERGY DEPENDENCE OF NUCLEAR CROSS SECTIONS. Arthur K. Kerman (Massachusetts Inst. of Tech., Cambridge), Leonard S. Rodberg, and James E. Young. Phys. Rev. Letters, 11: 422-5(Nov. 1, 1963). (LADC-5968)

It is suggested that intermediate resonance structure in the energy dependence of nuclear cross sections can be interpreted in terms of the excitation of particularly simple configurations of the compound system. The observed structure can arise from the formation of three-quasiparticle states in the compound system. (C.E.S.)

2939 PHOTOPRODUCTION OF NEGATIVE AND POSITIVE PIONS FROM CARBON AT FORWARD ANGLES. W. A. Blanpied, J. S. Greenberg, V. W. Huges, D. C. Lu, and R. C. Minehart (Yale Univ., New Haven). Phys. Rev. Letters, 11: 477-9(Nov. 15, 1963).

The production rates and cross sections were determined for the photoproduction of mesons (π^+) and (π^-) on carbon at bremsstrahlung energies of 2.91, 3.88, and 4.85 Bev. Positron production data were also determined to check on the normalization of the meson(π) data. Results were compared with the Drell peripheral collision model. (C.E.S.)

2940 THE BRANCHING RATIO OF THE $^{10}B(n,\alpha)^7Li$ REACTION. S. Malmskog (Aktiebolaget Atomenergi, Studsvik, Sweden). Physica, 29: 987-9(Sept. 1963).

The branching ratio for the production of Li^7 in the ground and first excited states in the $B^{10}(n,\alpha)$ reaction was determined by means of thermal neutrons incident on a BF_3 proportional counter. The branching ratio was calculated to be 6.47 ± 0.07%. (C.E.S.)

2941 RESONANCES IN THE REACTION $^{26}Mg(p,\gamma)^{27}Al$. C. Van der Leun and P. M. Endt (Rijksuniversiteit, Utrecht). Physica, 29: 990-8(Sept. 1963).

With protons in the energy range $E_p = 0.2-3.0$ Mev, one hundred and twenty resonances were found in the reaction $Mg^{26}(p,\gamma)Al^{27}$. About eighty of these resonances were not reported earlier. The resonance energies, the excitation energies, the resonance strengths, the total widths, and the main modes of decay of the corresponding Al^{27} levels are given. (auth)

2942 HALF-LIVES OF THE FIRST EXCITED STATES OF ^{102}Ru, ^{126}Xe, ^{196}Hg, ^{160}Dy, ^{164}Er, ^{166}Er, AND ^{180}W. Th. J. De Boer, E. W. Ten Napel, and J. Blok (Vrije Universiteit, Amsterdam). Physica, 29: 1013-23(Sept. 1963).

The half-lives of the first excited states of the even-even nuclei Ru^{102}, Xe^{126}, Hg^{196}, Dy^{160}, Er^{164}, Er^{166}, and W^{180} were measured by means of the delayed coincidence method. (auth)

2943 ANALYSIS AND INTERPRETATION OF THE NEUTRON CROSS SECTION OF VANADIUM BELOW 25 kev. F. W. K. Firk, J. E. Lynn, and M. C. Moxon (Atomic Energy Research Establishment, Harwell, Berks, Eng.). Proc. Phys. Soc. (London), 82: 477-87(Oct. 1, 1963).

The total neutron cross section of V^{51} was measured from a neutron energy of 600 to 25,000 ev. A many-level analysis of the cross section yields a value of the s-wave neutron strength function equal to $(10.7 \pm 2.6) \times 10^{-4}$ and strongly indicates the existence of spin-dependent s-wave potential scattering, the potential scattering length for angular momentum J = 3 being about 7.5f and that for J = 4 being about 5f or possibly even less. (auth)

2944 GAMMA-GAMMA ANGULAR CORRELATIONS IN ^{140}Ce. L. Dorikens-Vanpraet, O. Segaert, M. Dorikens, and J. Demuynck (Rijksuniversiteit, Ghent). Proc. Phys. Soc. (London), 82: 488-92(Oct. 1, 1963).

The spins and parities of the 1596-, 2083-, 2410-, and 2520-kev levels of Ce^{140} are shown to be 2^+, 4^+, 3^+, and 2^+ respectively. The quadrupole contents of the 330-, 487-, 923-, and 1596-kev transitions are respectively less than 0.003, 1, less than 0.005, 1. (auth)

2945 BREMSSTRAHLUNG EXCITATION OF SILVER ISOMERS. R. M. Benwell and E. Mathieson (Univ. of Leicester, Eng.). Proc. Phys. Soc. (London), 82: 803-5 (Nov. 1, 1963).

An attempt was made to excite some long-lived nuclear isomers with bremsstrahlung of maximum energy 0.8 Mev. Previously reported activities in lead and selenium were not found. Excitation of the silver isomers is discussed. (auth)

2946 ANOMALOUS PARITY STATES OF C^{13}, N^{13}, AND N^{14}. Takashi Sebe (Hosei Univ., Tokyo). Progr. Theoret. Phys. (Kyoto), 30: 290-326(Sept. 1963).

The low-lying anomalous parity states of C^{13} and N^{13} are shown to be well described in terms of the shell model states in which a positive-parity nucleon couples to a core that corresponds to C^{12} and its lowest two states are taken into account in the actual calculation. The Hamiltonian with a single-body spin-orbit interaction and a two-body central interaction is diagonalized among the above states and supplementary basic states. The latter basic states are necessary to remove spurious states, which must not be contained in the wave functions. The center-of-mass correction is seen to have a very important effect on the results. The results for the energy spectra in C^{13} are found to be in fair agreement with the experiment. The reason why the lowest positive-parity level $\frac{1}{2}^+$ of C^{13} is observed at a very small excitation energy (3.08 Mev) is elucidated. The agreements with experiment are also good on the Coulomb shifts between the isotopic doublets, on the reduced widths for the proton emission, and on various kinds of radiative transitions. A similar method of calculation is performed to investigate the properties of the negative-parity states of N^{14}, getting fair agreement with experiment. (auth)

2947 ON THE POSSIBLE EXISTENCE OF 1.33 Mev LEVEL IN Mg^{26}. Raj K. Gupta and P. C. Sood (Panjab Univ., Chandigarh, India). Progr. Theoret. Phys. (Kyoto), 30: 402-3(Sept. 1963).

Evidence is presented from the systematics of nuclear levels in 1d-2s shell even-even nuclei that appears to completely rule out the existence of the 1.33-Mev level in Mg^{26}. (C.E.S.)

2948 ELECTROMAGNETIC TRANSITION PROBABILITIES BETWEEN EXCITED STATES OF ODD NUCLEI WITH SMALL NON-AXIALITY. R. A. Sardaryan. Vestn. Mosk. Univ., Ser. III, Fiz., Astron., No. 4, 18-26(July-Aug. 1963). (In Russian)

Probabilities of electromagnetic transitions between intrinsic ground states inside the first abnormal band and states between the first abnormal band and the ground rotational-single particle band were calculated. (tr-auth)

2949 ON THE INTERACTION BETWEEN NUCLEAR ROTATION AND EXTERNAL NUCLEON MOTION IN ODD NONAXIAL NUCLEI WITH $j = \frac{1}{2}$. L. A. Malov. Vestn. Mosk. Univ., Ser. III, Fiz., Astron., No. 4, 68-78(July-Aug. 1963). (In Russian)

A collective model was used in investigating the case in which external nucleons in odd nuclei have moments of $j = \frac{1}{2}$. An extra term, considering the interaction between the core rotation and the nucleon motion, was added to the hamiltonian. The nucleon energy levels for the examined case, quadrupole electric and dipole magnetic moments, and probabilities of E-2 and M-1 transitions were calculated. The results were correlated with experimental data for Yb^{171}, Tm^{171}, W^{183}, Fr^{223}, and Pu^{239}. (tr-auth)

2950 ON A METHOD OF CALCULATION OF NON-AXIAL ROTATIONAL WAVE FUNCTIONS AND ENERGY LEVELS OF ODD-A NUCLEI. Wen-shu Han, You-liang Sou, and Ing-chou Yan. Wu Li Hsueh Pao, 19: 99-102 (Feb. 1963). (In Chinese)

A method for calculating non-axial rotational wave functions and energy levels of odd-A nuclei by means of that of even-even nuclei is presented. (auth)

2951 THE SUPERFLUIDITY EFFECTS IN LIGHT NUCLEI. C. Y. Tseng, Q. Z. Shan, and L. S. Cheng (Peking Univ.). Wu Li Hsueh Pao, 19: 360-9(June 1963). (In Chinese)

The effects of the pairing force on the nuclear structure of nuclei F^{19}–Mg^{24} were analyzed. It is found that with the coupling strength G, $G \times A \sim 16$–18 Mev, the observed moments of inertia of these nuclei can be predicated very well. well. The estimated even-odd mass difference P, in general, is a little larger than the energy gap in light nuclei. The fluctuation of the number of particles is $\Delta N \sim 1$–1.5. The neglected higher-order terms in Bogolyubov-Belyaev's theory are also discussed. The main difficulties of the theory are the nonconservation of the number of particles, the treatment of excited states, and the up pairing force. (auth)

2952 Tb^{160} DECAY INVESTIGATION OF EXCITED LEVELS OF STRONGLY DEFORMED RARE EARTHS. PART III. P'ei-K'un Wung, Go-guan Yan, Shan-ken Chu, Shih-p'ing Ch'en, Sen Huo, Shu-fang Wang, and Lin-sheng Cheng. Wu Li Hsueh Pao, 19: 524-37(Aug. 1963). (In Chinese)

The decay of Tb^{160} was investigated by means of a double-lens magnetic β spectrometer, magnetic β spectrometer with double focusing, and scintillation methods. Five β branches were observed. Their energy, intensity, and log ft values were given. Twenty-seven γ transitions were also determined. From the data on γ-γ cascade correlations and energy of the γ transitions, fourteen excited states were determined for Dy^{160}. Their energies, spins, and parities were given. The characteristics of the excited states in Dy^{160} were discussed. (tr-auth)

2953 [PROCEEDINGS OF] SYMPOSIUM ON STATISTICAL PROPERTIES OF ATOMIC AND NUCLEAR SPECTRA, MAY 3, 1963, STONY BROOK, NEW YORK. Peter B. Kahn, ed. Stony Brook, N. Y., State University of New York, [1963]. 6 papers. (CONF-218)

Copies of these proceedings are available from the editor.

Separate abstracts were prepared for four papers on statistical analysis of neutron resonance parameters, resonance statistics effects on average cross sections, and correlations and spacing distributions for nuclear levels. Two other papers on neutron resonance parameter measurement and statistical analysis of complex spectra were previously abstracted in NSA (17: 39968 and 17: 39452). (D.C.W.)

For abstracts of individual papers see: 2954, 2955, 2956, and 2957.

2954 A STATISTICAL ANALYSIS OF NEUTRON RESONANCE PARAMETERS. John D. Garrison (Brookhaven National Lab., Upton, N. Y.). Paper 3 of "[Proceedings of] Symposium on Statistical Properties of Atomic and Nuclear Spectra, May 3, 1963, Stony Brook, N. Y." Stony Brook, N. Y., State University of New York, [1963].

The neutron resonance parameter data were examined with emphasis on recent measurements. The results obtained provide general support for the theory of nuclear reactions and the statistical theory of spectra. 72 references. (auth)

2955 SPACING DISTRIBUTIONS AND CORRELATIONS BETWEEN LEVELS OF COMPLEX NUCLEAR SPECTRA. J. B. Garg (Columbia Univ., New York). Paper 4 of "[Proceedings of] Symposium on Statistical Properties of Atomic and Nuclear Spectra, May 3, 1963, Stony Brook, N. Y." Stony Brook, N. Y., State University of New York, [1963].

A systematic investigation of the level spacing distribution, the next-nearest spacing distribution, and correlations between levels indicates that the random matrix model approach agrees reasonably well with experimental data and establishes the effect of repulsion of levels. (D.C.W.)

2956 RESONANCE STATISTICS AND AVERAGE CROSS SECTION. P. A. Moldauer (Argonne National Lab., Ill.). Paper 5 of "[Proceedings of] Symposium on Statistical Properties of Atomic and Nuclear Spectra, May 3, 1963, Stony Brook, N. Y." Stony Brook, N. Y., State University of New York, [1963].

An evaluation of the cross section for neutron reactions (n,n') in the extreme resonance region, for three correlation cases, indicates that the average reaction cross section can be expected to increase with increasing correlation of partial widths and to decrease with increasing negative correlations. (D.C.W.)

2957 REMARKS ON HIGHER ORDER SPACING DISTRIBUTIONS. Peter B. Kahn (State Univ. of New York, Stony Brook). Paper 6 of "[Proceedings of] Symposium on Statistical Properties of Atomic and Nuclear Spectra, May 3, 1963, Stony Brook, N. Y." Stony Brook, N. Y., State University of New York, [1963].

Analytic computations of spacing distributions are briefly reviewed, and a formula is derived for the Nth order spacing distribution. (D.C.W.)

2958 GROUP THEORETICAL APPROACHES TO NUCLEAR SPECTROSCOPY. L. C. Biedenharn (Duke Univ., Durham, N. C.). p.258-421 of "Lectures in

Theoretical Physics. Vol. V." New York, Interscience Publishers, 1963.

Group theory and group representations are discussed. The Lie-Cartan-Weyl methods for treatment of the general unitary group are outlined. Other topics include the SU_2 group, invariants, the state labeling problem, and the unimodular unitary group SU_3. Applications of group theory to nuclear spectroscopy are considered. A bibliography of 175 references is included. (C.E.S.)

2959 ISOBARIC NUCLEI WITH THE MASS NUMBER A = 74. B. S. Dzhelepov. Translated from Russian by Prasenjit Basu. A Pergamon Press Book. International Series of Monographs on Nuclear Energy. New York, The MacMillan Company, 1963. 62p.

The decay schemes, decay spectra, half lives, and properties of the isobaric isotopes Ga^{74}, As^{74}, and Br^{74} are discussed. The properties of the ground and excited states of the stable isobaric isotopes Ge^{74} and Se^{74} are considered. A bibliography is included for each of the isotopes. (C.E.S.)

2960 ISOBARIC NUCLEI WITH THE MASS NUMBER A = 110. B. S. Dzhelepov and N. N. Zhukovskii. Translated from Russian by R. F. Kelleher. A Pergamon Press Book. International Series of Monographs on Nuclear Energy. New York, The MacMillan Company, 1963. 95p.

The decay schemes, decay spectra, half lives, and properties of the isobaric isotopes Ag^{110}, In^{110}, and Sn^{110} are discussed. The properties of the ground and excited states of the stable isobaric isotopes Pd^{110} and Cd^{110} are considered. A bibliography is included for each of the isotopes. (C.E.S.)

2961 ISOBARIC NUCLEI WITH THE MASS NUMBER A = 140. B. S. Dzhelepov, V. P. Prikhodtseva, and Yu. V. Khol'nov. Translated from Russian by Prasenjit Basu. A Pergamon Press Book. International Series of Monographs on Nuclear Energy. New York, The MacMillan Company, 1963. 136p.

The decay schemes, decay spectra, half lives, and properties of ground and excited states of the isobaric isotopes Xe^{140}, Cs^{140}, Ba^{140}, La^{140}, Ce^{140}, Pr^{140}, and Nd^{140} are discussed. A bibliography is included for each isotope. (C.E.S.)

2962 THE ENERGIES OF THE LOW LYING LEVELS OF Sr-88 AND Ti-46. A. A. Bartlett, Johnnie R. Keith, and W. Dale King (Univ. of Colorado, Boulder). 7p. (CONF-250-12)

From American Physical Society 1963 Summer Meeting in the West, Edmonton, Can., Aug. 1963.

The decay of 105-day Y^{88} and of 85-day Sc^{46} is studied with a double-focusing beta-ray spectrometer. The method of superposition of external conversion spectra is used, with Co^{60} as the reference standard. The energies measured for the two strong gamma rays of Y^{88} are 897.5 ± 0.5 and 1836.6 ± 0.9 kev. An examination of the internal conversion electron spectrum of Sc^{46} in the energy range from 50 kev to 2 Mev shows that no previously unknown transitions exist with an electron intensity greater than 2 percent of the intensity of the two main transitions. The energies and intensities of the two strong gamma rays of Sc^{46} are found to be 1119.2 ± 0.6 (100) and 888.3 ± 0.4 kev (110 ± 15). (auth)

2963 INELASTIC NEUTRON CROSS SECTIONS OF Fe^{56}, Cu^{63}, Zr^{90}, Ba^{138} AND Ce^{140}. A. B. Tucker, J. T. Wells, and W. E. Meyerhof (Stanford Univ., Calif.). 8p. (CONF-30-5)

From American Physical Society 1962 Winter Meeting in the West, Stanford, Calif., Dec. 1962.

Total inelastic neutron cross sections are determined by detecting gamma radiation resulting from the inelastic excitation. Corrections are applied for the angular anisotropy of the gamma radiation and for multiple scattering. Isotopic cross sections are given at the specified mean neutron energies in the center of mass system. (auth)

2964 FAST-SPECTRUM DOPPLER MEASUREMENTS. T. H. Springer and S. G. Carpenter (Atomics International, Canoga Park, Calif.). Trans. Am. Nucl. Soc., 6: 242(Nov. 1963).

2965 THE COMPUTATION OF DOPPLER-BROADENED CROSS SECTIONS. E. M. Gelbard (Westinghouse Electric Corp., Pittsburgh). Trans. Am. Nucl. Soc., 6: 257-8(Nov. 1963).

2966 EFFECTIVE RESONANCE-ABSORPTION INTEGRALS FOR PLUTONIUM-240. D. A. Klopp (Illinois Inst. of Tech., Chicago). Trans. Am. Nucl. Soc., 6: 258-9 (Nov. 1963).

2967 A STUDY OF THE FISSION YIELDS OF AMERICIUM-241. R. R. Rickard, C. F. Goeking, Jr., and E. I. Wyatt (Oak Ridge National Lab., Tenn.). Trans. Am. Nucl. Soc., 6: 261(Nov. 1963).

2968 VARIATION OF FISSION-FRAGMENT KINETIC-ENERGY DISTRIBUTION AND YIELD OF LONG-RANGE ALPHA PARTICLES IN THE RESONANCE-NEUTRON-INDUCED FISSION OF U-235. E. Melkonian and G. K. Mehta (Columbia Univ., New York). Trans. Am. Nucl. Soc., 6: 262(Nov. 1963).

2969 MULTILEVEL EFFECTS IN NEUTRON SCATTERING AND CAPTURE CROSS SECTION. D. R. Harris and C. B. Noll (Westinghouse Electric Corp., Pittsburgh). Trans. Am. Nucl. Soc., 6: 262-3(Nov. 1963).

2970 A MONTE CARLO STUDY OF RESONANCE ABSORPTION IN GOLD AND INDIUM LUMPS. W. K. Foell, R. A. Grimesey, and S. Tong (Phillips Petroleum Co., Idaho Falls, Idaho). Trans. Am. Nucl. Soc., 6: 272-3(Nov. 1963).

2971 FLUXES AND REACTION RATES IN THE PRESENCE OF INTERFERING RESONANCES. C. N. Kelber (Argonne National Lab., Ill.). Trans. Am. Nucl. Soc., 6: 273(Nov. 1963).

2972 NEUTRON ACTIVATION CROSS SECTIONS FOR THE Co-60 ISOMERS. C. H. Hogg and L. D. Weber (Phillips Petroleum Co., Idaho Falls, Idaho). Trans. Am. Nucl. Soc., 6: 420(Nov. 1963).

2973 MÖSSBAUER SCATTERING OF 14.4 Kev GAMMA RAYS FROM Fe^{57} AS A FUNCTION OF TEMPERATURE. P. Debrunner and R. J. Morrison (Univ. of Illinois, Urbana). 17p. (CONF-303-2)

From 3rd International Conference on the Mössbauer Effect, Ithaca, N. Y., Sept. 1963.

The scattering of iron-57 gamma rays from a stainless steel foil was studied for temperatures of the scatterer from 20 to 300°C. The source, cobalt-57 in stainless steel, and the stainless steel scatterer exhibited single lines. The total scattering and the transmission of the scatterer were determined as a function of the source velocity. For the same temperatures, the line shape of the scattered radiation was measured by standard transmission techniques. The energy distribution of the source was centered on the scatterer resonance. This required that the source be Doppler shifted by a constant velocity motion to compensate for the temperature shift. From the line shape data the ratio of the recoilless to the non-recoilless scattering was determined and used to evaluate f for two different

scattering foils. The recoilless fraction, f, is found to vary linearly from 0.69 ± 0.01 at room temperature to 0.51 ± 0.02 at 300°C. These values are consistent with the Debye model using a Debye temperature of (331 ± 12)°K. (auth)

2974 SURFACE EXCITATIONS OF THE Si^{31} NUCLEUS. M. I. Guseva, K. I. Zherebtsova, V. F. Litvin, and Yu. A. Nemilov. Vestn. Leningr. Univ., No. 10, Ser. Fiz. i Khim., No. 2, 130(1963). (In Russian)

Angular distributions of proton groups from the $Si^{30}(d,p)Si^{31}$ reaction are investigated by means of a magnetic analyzer-multispectrograph. (auth)

Plasma Physics and Thermonuclear Processes

2975 (AD-283026) RESEARCH IN MAGNETOGASDYNAMICS. Final Technical Report. J. H. deLeeuw (Toronto. Univ. Inst. of Aerophysics). Mar. 28, 1962. Contract AF49(638)-823. 14p.

Two plasma tunnels for producing ionized gas flows were constructed, and the effect of flow on the readings of Langmuir probes was investigated. The plasma boundary layer in the vicinity of the stagnation point of a blunt body in a continuum flow was studied with a Langmuir probe. The efficiency of conversion of electrical energy into the energy of directed motion of the propellent gas in a magnetically driven shock system was determined to be about 20%, using a Tee-tube arrangement. Pressure level had no systematic effect on the efficiency. Preliminary work on experiments to study the interaction of shock-ionized argon with a magnetic field and the effect of a magnetic field on the properties of the boundary layer in an electrically conductive gas is also reported. (D.C.W.)

2976 (CEA-2048) RALENTISSEMENT DE PARTICULES TEST DANS UN PLASMA. (Slowing Down of Test Particles in a Plasma). P. Belayche, P. Chavy, M. Dupoux, and J. Salmon (France. Commissariat à l'Énergie Atomique, Paris). 1961. 18p.

A numerical solution of the Fokker-Planck equation for triton attenuation in a deuterium plasma is presented. The temperature and energy distribution functions for the tritons at successive times are obtained. The numerical results are analyzed and, as far as possible, mathematically explained. (auth)

2977 (CLM-R-29) THETATRON—A TWO-DIMENSIONAL MAGNETOHYDRODYNAMIC COMPUTER PROGRAMME. PART I. GENERAL DISCUSSION. K. V. Roberts, F. Hertweck, and S. J. Roberts (United Kingdom Atomic Energy Authority. Research Group. Culham Lab., Culham, Abingdon, Berks, England). June 1963. 22p.

The physical model used in the Thetatron program, which follows the behavior of a θ-pinch plasma in the (r,z) plane, is described. The basic differential equations and boundary conditions are defined, and the numerical methods are discussed. The program is in FORTRAN II for the IBM 704, 709, or 7090 and in S1-FORTRAN for the IBM 7030. (auth)

2978 (CONF-46-109) BOUNDS ON PLASMA INSTABILITY GROWTH RATES. T. K. Fowler (Oak Ridge National Lab., Tenn.). [1963]. Contract W-7405-eng-26. 23p.

From American Physical Society 1963 Spring Meeting, Washington, D. C., Apr. 1963.

A method is presented for obtaining upper bounds on the growth rate of plasma instabilities predicted by the linearized Vlasov equation. The technique is applicable to spatially non-uniform equilibria not amenable to conventional analysis. As examples, radially confined arc columns and mirror machine configurations are discussed. The fastest growth in these systems corresponds to that of known electrostatic instabilities in uniform, infinite plasmas. For arbitrary equilibria, it is shown that growth is always slower than some exponential, the plasma frequency being a typical maximum growth constant. Growth is strongly limited for equilibria near a stable state. For example, the streaming instability growth rate vanishes at least linearly with the streaming speed. (auth)

2979 (IPPJ-11) PROPAGATION OF HYDROMAGNETIC WAVES IN A COLLISIONLESS PLASMA. Yusuke Kato and Tosiya Taniuti (Nagoya, Japan. Univ. Inst. of Plasma Physics). May 1963. 24p.

A collisionless plasma is treated as a hydrodynamical system in the Chew-Goldberger-Low approximation. The dispersion relation for weak, plane disturbances in a uniform plasma is derived. It is shown that the fast and slow magnetoacoustic waves and the Alfvén wave exist as well as two degenerate waves that propagate with fluid velocity. The condition such that the system is totally hyperbolic is given, and the configuration for which the system is partially elliptic is investigated in detail especially for the slow wave. (auth)

2980 (IPPJ-15) RESONANCE PROBE IN A MAGNETIC FIELD. J. Uramoto, H. Ikegami, and K. Takayama (Nagoya, Japan. Univ. Inst. of Plasma Physics). Oct. 1963. 14p.

Electron cyclotron resonance was observed by a resonance probe applied to a plasma in a magnetic field. The resonance appears only when the magnetic field is perpendicular to the r-f electric field, that is, parallel to the surface of the plane probe in this case and only when the cyclotron frequency exceeds the electron plasma frequency, which is called ordinary resonance. The ordinary resonance seems to disappear when the cyclotron resonance is observed. As the magnetic field intensity is increased, the ordinary resonance peak is changed into the cyclotron resonance and its frequency begins to increase proportionally to the magnetic field intensity. Its behavior depends also on both the background pressure and the probe potential. Experimentally, it is confirmed that at the cyclotron frequency electrons are heated up by the r-f electric field. No heating is observed at the ordinary resonance frequency. (auth)

2981 (MATT-Q-20) SEMIANNUAL REPORT [ON PLASMA PHYSICS] COVERING THE PERIOD JULY 1, 1962–DECEMBER 31, 1962. (Princeton Univ., N. J. Plasma Physics Lab.). Mar. 13, 1963. Contract AT(30-1)-1238. 238p.

Theoretical conditions required for plasma equilibrium were tested on the Model C stellarator showing good experimental and theoretical agreement. Equilibrium of a toroidal plasma with a conducting aperture limiter was also examined experimentally and theoretically. Measurements of floating potential differences at the bottom and top showed a pronounced positive potential peak. Studies of the effect of a helical field on plasma behavior showed the measured transform to agree well with the calculated values. Use of the absolute intensities of spectral lines in the vacuum ultraviolet region of stellarator emission for diagnostic purposes was examined; a vacuum monochromator device was used with acceptable results on the stellarator. A technique was developed for using the

change in the ratio of the intensity of certain resonance multiplets of impurity ions to determine the electron temperature; tests using various impurity ions showed varying agreement with other determinations. Temperature determinations made using Doppler broadening of spectral lines compared well with the conductivity temperature at low currents. The vacuum ultraviolet monochromator was used to study the power loss due to impurity radiation; the power loss was compared to the input power. For a He discharge, between 30 and 100% of the input energy was lost as radiation. Current steps in the current trace of plasmas dominated by runaway electrons were examined. No appreciable change in cyclotron radiation was noted for step losses to the wall; for the absorption type of steps, the data support a model involving an electron-electron two stream instability. A 4-mm microwave interferometer was used to study the electron density distribution by measuring the propagation of the extraordinary mode. The dispersion curves compare favorably with graphs of a theoretical cold plasma dispersion relation. The return of the hydrogen gas that is removed during ohmic heating was also studied. Neutral gas return from the walls was found time dependent, and the percentage return proved small for several msec. The Etude device was used to investigate the presence of fluctuating electric fields transverse to the confining field as a cause of high electron loss during ohmic heating. The arrangement was deemed capable of accounting for ion diffusion across the magnetic field and for part of the electron diffusion. Experimental and theoretical curves for potential distribution made with the L-2 device agree well. Plasma heating by absorption of ion-cyclotron waves in a region of decreasing magnetic field was investigated in the B-66 device using diamagnetic probe measurements, an ion energy analyzer, and impurity measurements. The waves were concluded to heat deuterons to a temperature around 100 v. The Q-1 low-temperature Cs plasma device was used to study longitudinal transport phenomena. At low currents experimental and theoretical results agreed. Research on damping and propagation of ion acoustic waves in highly ionized plasmas gave evidence for collisionless damping of ion waves. Langmuir probes were used in an extensive study of space and time dependence of the plasma density in a Stellarator. Results are graphed. Work in kinetic theory included development of a convergent classical kinetic equation for a plasma, derivation of a two-particle correlation function for an unstable plasma, investigation of charge neutrality for a Coulomb system in thermal equilibrium, and extension of the expansion for a weakly coupled spatial homogeneous system to fourth order. Stability studies dealt with the effect of a finite gyration radius on stellarator stability, the effect of finite conductivity on hydromagnetic instabilities, stability of hydromagnetic systems with dissipation, some results of quasi-linear theory, computer investigations of current instabilities, and the effects of viscosity and heat conductivity upon oscillations of current-carrying plasmas. The high-frequency conductivity of a plasma was also studied; quantum effects, presence of magnetic fields, and ion dynamics are dealt with. Scattering of radiation by plasma with inclusion of short-range effects was also investigated. Consideration of breakdown and heating by large amplitude magnetic pumping shows ohmic heating to be unnecessary for ionization. A simpler method for calculating the adiabatic invariant of the harmonic oscillator to higher order was developed, and an asymptotic analysis of the velocity distributions of electrons in a weak electric field was performed. Description of the positive column of a glow discharge by a simple macroscopic model was considered, and calculations on the width of the λ4686 line of He II were revised. Ion energy distribution and impurity content of plasma from a coaxial plasma were measured at capacitor voltages to 20 kv. Development and testing of low-loss high-Q capacitor modules for magnetic pumping continued. A method for rapid evaluation of the Doppler temperature was devised, and the concentric ring photoelectric Fabry-Perot interferometer was successfully adapted to Model C research. Comparison of nude and enclosed ion gauges on an oil-free system revealed a nude gauge to be better for low pressure readings. Behavior of AgCl in a vacuum was examined as was the decay rate for a superconducting current. An accurate, compact device for determining the axis of a coil was also constructed. (D.C.W.)

2982 (NASA-TN-D-1111) A MATHEMATICAL TREATMENT OF THE PROBLEM OF DETERMINING THE EIGENVALUES ASSOCIATED WITH A PARTITION FUNCTION OF AN ATOM IN THE INTERIOR OF A PLASMA. E. Baylis Shanks (National Aeronautics and Space Administration. George C. Marshall Space Flight Center, Huntsville, Ala.). Oct. 1963. 9p.

The determination of the numerical values of some of the eigenvalues and the total number of eigenvalues of the differential equation $x^2p'' + [2dxe^{-x} - k(k+1) - u^2d^2x^2]P = 0$ is considered. The problem is first treated from a theoretical standpoint. Then numerical techniques are developed that lead to approximations of the eigenvalues. An approximate inequality is obtained for the number of eigenvalues, and an approximate equation is obtained for the eigenvalues. Tabular data are shown listing a total of 55 of these eigenvalues for nine different cases. (auth)

2983 (NASA-TN-D-1992) SHEATH NEAR A PLANE ELECTRODE BOUNDING A COLLISIONLESS PLASMA IN A MAGNETIC FIELD. Arthur W. Goldstein (National Aeronautics and Space Administration. Lewis Research Center, Cleveland). Oct. 1963. 38p. (N63-22572)

The entire plasma-sheath region is treated by a uniform method for an infinite plane electrode that adjoins a semi-infinite plasma in an electrical field normal to the electrode and a magnetic field parallel to the electrode. The effect of collisions is neglected in calculating the velocity distribution function. Both ions and electrons drift perpendicularly to the electric and magnetic fields, but there is no current to the electrode. A self-consistent potential is calculated, as well as the macroscopic properties of the electron and ion fluids, density, velocity, and pressure tensor components, for a hydrogen plasma in thermal equilibrium. An equilibrium velocity distribution and an isotropic pressure tensor are shown to be established at a distance more than several times the Larmor radius for each species; this minimal distance is reduced for ions in a sheath of large electron surplus. If the plasma density is sufficiently low, the entire transition region is electrically charged, while, near an anode in a plasma of higher density, the charge extends only to several times the Debey distance. In the latter case, there is also an exterior region of charge neutrality and potential disturbance that extends to several times the electron Larmor radius for a large anode potential and to several times the ion Larmor radius for other electrode potentials. (auth)

2984 (R63SD87) THE EFFECT OF COLLISION SIZE ON THE BOLTZMANN EQUATION. F. W. Mezger (General Electric Co. Missile and Space Div., Valley Forge Space Technology Center, King of Prussia, Penna.). Oct. 1963. 22p.

Several possible generalizations of the master equation

and the Boltzmann equation that take into account the finite size of collisions are presented. The generalizations result from combining trajectory and collision models. The Boltzmann generalization should be applicable to problems for which particle correlation effects are not important over distances comparable with the collision size. (auth)

2985 (UCRL-10852) CONTROLLED THERMONUCLEAR RESEARCH SEMIANNUAL REPORT, JANUARY THROUGH JUNE 1963. (California. Univ., Berkeley. Lawrence Radiation Lab. and California. Univ., Livermore. Lawrence Radiation Lab.). July 22, 1963. Contract W-7405-eng-48. 148p.

Research progress on magnetic mirror devices, the Astron concept, pinch devices and theory, plasmas, and plasma physics is reported. Engineering and technological development is summarized. (D.C.W.)

2986 ON THE MECHANISMS OF CANAL RAY DISCHARGE. [PART] II. D. Kamke and F. W. Richter (Physikalisches Institut, Marburg/Lahn, Ger.). Ann. Physik. (7), 10: 360-90(1963). (In German)

Canal beam discharge is a special form of the usual glow discharge. Studies were made of the positive discharge characteristics. The position characteristics were measured. The influence of the cathode-released electrons on the discharge was determined. Special characteristics of the anode-side of the discharge space were measured. Results and theory are compared. (M.C.G.)

2987 PLASMADYNAMICS. Daniel Bershader (Stanford Univ., Calif. and Lockheed Missiles and Space Co., Sunnyvale, Calif.). Astronaut. Aerospace Eng., 1: 94-7 (Nov. 1963).

Nonequilibrium ionization in thermal plasmas and plasma sheaths and wakes associated with hypersonic reentry vehicles are discussed. Recent developments in plasma diagnostics and solid-state plasmas are also presented. (R.E.U.)

2988 CARTESIAN TENSOR EXPANSION OF THE FOKKER-PLANCK EQUATION. I. P. Shkarofsky (RCA Victor Co., Ltd., Montreal). Can. J. Phys., 41: 1753-75 (Nov. 1963).

The Fokker-Planck equation is expanded via Cartesian tensors. The results, valid for arbitrary mass ratio, reduce to known expressions for the f_0 (isotropic) and f_1 (directional) parts of the distribution. The same analysis also gives the relation for the f_2 (tensor) part of the distribution. Nonlinear and recoil terms are also investigated. The f_0 relation yields relaxation times and energy equipartition times for arbitrary velocity distributions. The ion recoil term is important for low-frequency waves in the electron f_1 equation but is negligible in the electron f_2 equation. The electron-electron contributions to the f_1 and f_2 collisional terms are of the same order as the electron-ion contributions. Except for momentum transfer calculations, the ion-ion collisional terms dominate the ion-electron terms in the ion collision equations referring to the directional (F_1) and tensor (F_2) parts of the ion distribution. (auth)

2989 INCLUSION OF FLOW TERMS IN THE CARTESIAN TENSOR EXPANSION OF THE BOLTZMANN EQUATION. I. P. Shkarofsky (RCA Victor Co., Ltd., Montreal). Can. J. Phys., 41: 1776-86(Nov. 1963).

The Cartesian tensor expansion of Boltzmann's equation is extended to include terms denoting gradients in flow velocity. The expansion is performed in intrinsic velocity space. The gradient velocity terms yield a linear contribution to the tensor (f_2) part of the angle-integrated distribution function from which the zero-trace pressure tensor is calculable. It is shown that the standard moment equations are obtained by further integration over the magnitude of velocity. For the case of a completely ionized gas, collisional terms are inserted appropriately. (auth)

2990 CALCULATION OF THE PRESSURE TENSOR IN A FULLY IONIZED PLASMA. I. P. Shkarofsky (RCA Victor Co., Ltd., Montreal). Can. J. Phys., 41: 1787-1800 (Nov. 1963).

The tensor part of the pressure arising from gradients in flow velocity is calculated from the Fokker-Planck equation by using the Cartesian tensor expansion in direction cosines of the intrinsic velocity vectors and the Laguerre expansion for the magnitude of the intrinsic velocities. Wavelike perturbations and magnetic fields are included and both the electron and ion pressure tensors are investigated. The results are compared with those derived by other approaches. (auth)

2991 A CYLINDRICAL IONIZING SHOCK IN A TRANSVERSE MAGNETIC FIELD. François Cabannes and Maurice Skowronek. Compt. Rend., 257: 1599-1601 (Aug. 26, 1963). (In French)

During the study of the explosion of a filiform channel of preionized gas, a cylindrical ionizing shock being propagated in a transverse magnetic field was observed. Observation of the propagation during the first three microseconds showed that the shock is displaced in atmospheric air, its velocity is almost constant, and the shock is displaced in the transverse magnetic field created by the discharge current. By knowledge of the conditions in front of the shock and the velocity of the shock, a study was made to determine the conditions of the plasma behind the shock. It is shown that it is probable that a shock with Mach number 15 in atmospheric air is not a magnetodynamic shock. The luminance temperature was measured and varied from 9000 to 22000°K. (J.S.R.)

2992 INSTABILITIES AND CROSSED WAVES IN SPACE. Paul Rolland. Compt. Rend., 257: 1838-9 (Sept. 16, 1963). (In French)

It is shown that the existence and the nature of instabilities and waves in space can be deduced from certain properties of the dispersion equation. The criterion obtained is more general and more precise than those formulated previously. (tr-auth)

2993 MAGNETOHYDRODYNAMICS. Theodore von Karman. Fiz. Szemle, 13: 227-30(Aug. 1963).

The fundamental laws of plasma physics as applied to the case of the unidimensional flow of conducting fluids are listed, and a few applications of magnetohydrodynamical theory in the field of supersonic air travel and space travel are briefly sketched. (TCO)

2994 APPLICATION OF PLASMA PHYSICS IN THE CONSTRUCTION OF ELECTRIC ROCKET ENGINES. Erno Nagy (Eotvos Lorand Univ., Budapest). Fiz. Szemle, 13: 232-9(Aug. 1963).

A mathematical discussion of the various aspects of electric rocket engines including ideal jet velocity, specific impulse, total impulse, and initial thrust is presented. In engines employing neutral plasma the propellent is partly or fully ionized. The behavior of plasma is discussed and methods of its acceleration treated. A number of plasma generators are described including the AVCO experimental arc-discharge rocket engine. (TCO)

2995 MICROWAVE DIAGNOSTICS OF PLASMOIDS. Yu. S. Azovskii, I. T. Guzhovskii, L. A. Dushin, V. I. Privezentsev, and V. A. Churaev. Inzh. Fiz. Zh., Akad.

Nauk Belorussk. SSR, 6: No. 9, 57-60(Sept. 1963). (In Russian)

The distribution of electron concentration along a plasmoid length and the transitional velocity of a plasmoid are studied. The plasmoid is produced by a conical source and moves in a glass tube 6 cm in diameter. The electron concentration is defined by a cut-off microwave signal; probing was made simultaneously at three frequencies. It is found that the plasmoid has a sharp front boundary. The electron concentration monotonously increases with voltage on a bank of condensers. The transitional velocities of plasmoid layers with densities of charged particles 1×10^{12} and 5×10^{10} cm^{-3} are measured. The velocity of a high-density layer is measured by the Doppler effect when a microwave signal is reflected from the frontal surface of the plasmoid and that of a low-density layer, by a cavity resonator where the microwave of type H_{11} is excited. (auth)

2996 CHARACTERISTICS OF PLASMA PENETRATING BEYOND DISCHARGE SPACE. G. V. Krivoshchekov and I. N. Kalistratova (Inst. of Radiophysics and Electronics, Academy of Sciences, Novosibirsk, USSR). Izv. Sibirsk. Otd. Akad. Nauk SSSR, No. 6, Ser. Tekhn. Nauk, No. 2, 121-3(1963). (In Russian)

Studies of arc discharge in mercury vapor indicate that the plasma propagates beyond the limits of the anode discharge. Moreover, an additional acceleration alters the propagation. Experiments were carried out in order to verify the propagation process and to determine the possibility of using the electron flux in super-high frequency devices with ionic focusing. The design of a device for measuring the phenomenon is described, and a picture is shown of electron beam passage through the collector at 1500 v (argon pressure, 4×10^{-3} mm Hg). (R.V.J.)

2997 BEAM-PLASMA DISCHARGE: BUILDUP OF OSCILLATIONS. W. D. Getty and L. D. Smullin (Massachusetts Inst. of Tech., Cambridge). J. Appl. Phys., 34: 3421-9(Dec. 1963).

Plasma electron heating was accomplished by exciting plasma oscillations with a pulsed, 10-kv, 1-amp electron beam drifting in a longitudinal magnetic field of 100 to 1000 Oe. The oscillatory energy gained by plasma electrons leads to an increase in their density and mean kinetic energy. The resulting plasma, which is called the beam-plasma discharge, is an r-f discharge in which a beam-plasma interaction generates the r-f fields. At the beginning of a beam pulse, beam electrons generate a plasma by ionization of the background gas. Within a few microseconds excited plasma electrons become the dominant ionization source. The transient r-f oscillations that appear in the first few microseconds of the beam pulse are described. From a detailed study of this transient it was concluded that a nonconvective instability initiates the oscillations, which first appear at the electron cyclotron frequency, and that a convective instability at the plasma frequency generates the oscillations that sustain the discharge. (auth)

2998 A LOW-DENSITY PLASMA FOR MOLECULAR ION DISSOCIATION. W. L. Stirling, O. D. Matlock, H. C. Hoy, and V. J. Meece (Oak Ridge National Lab., Tenn.). J. Appl. Phys., 34: 3466-9(Dec. 1963).

A hydrogen arc was developed which produces a low-density plasma column. The electrodes of the arc discharge are geometrically arranged such that the plasma drifts through a hole in the arc anode along a flux tube of the confining magnetic field. A differentially-pumped vacuum system was constructed which achieved a base pressure of 2.5×10^{-10} Torr in the inner liner region while at liquid-nitrogen temperature. A density of about 10^{10} particles cm^{-3} can be achieved in the plasma column contained in the inner liner region, down field from the arc chamber, with a gas flow of 2 cm^3 min^{-1} into the arc chamber. At this flow, the pressure in the inner liner rises to 3×10^{-9} Torr. The ion-to-neutral density ratio under these conditions is about 30 to 1 in the inner liner region. (auth)

2999 ON THE STABILITY OF A PLASMA DIODE. Louis Gold (Kennecott Copper Corp., Lexington, Mass.). J. Electron. Control (1), 15: 319-24(Oct. 1963).

Appropriate analysis of an earlier-derived time-dependent parametric solution for the current-voltage response of a planar plasma diode is found to admit an exact solution so long as the electron transit time is too short to excite the natural resonances of the plasma. This latter concept, applicable to finite plasmas, has apparently not been recognized heretofore. Thus it is possible to observe d–c response of such a diode above a lower energy region which is unstable and manifests a–c output; the nature of the criterion for the transition separating the two regimes is characterized and its modification under certain boundary conditions appraised for the cold plasma limit with allowance, also, for the onset of relativistic effects. (auth)

3000 A PLASMA INSTABILITY RESULTING IN FIELD-ALIGNED IRREGULARITIES IN THE IONOSPHERE. D. T. Farley, Jr. (Jicamarca Radar Observatory, Lima). J. Geophys. Res., 68: 6083-97(Nov. 15, 1963).

A theory of the two-stream ion wave instability in a plasma is developed that takes into account both the effect of collisions of the ions and electrons with neutral particles and the presence of a uniform magnetic field. Applying the results to the ionosphere, it is found that irregularities of ionization density should arise spontaneously in regions in which a sufficiently strong current is flowing normal to the magnetic field lines. These irregularities will be strongly aligned with the magnetic field and may have a wide range of wavelengths. The various predictions of the theory are in agreement with the observed characteristics of certain field-aligned irregularities found in the equatorial ionosphere that are associated with the equatorial electrojet. Similar irregularities often appear in the polar ionosphere during auroral displays; it seems very likely that these are caused by the auroral electrojet. (auth)

3001 PLASMA RESONANCES IN THE UPPER IONOSPHERE. W. Calvert and G. B. Goe (National Bureau of Standards, Boulder, Colo.). J. Geophys. Res., 68: 6113-20(Nov. 15, 1963).

Plasma resonances, detected in the upper atmosphere were examined. The resonant frequencies were found to be f_N and $(f_N^2 + f_H^2)^{1/2}$, where f_N is the plasma frequency and f_H is the electron gyrofrequency. The two resonances are attributed to electron oscillations along and across the geomagnetic field, respectively. (auth)

3002 TRANSPORT COEFFICIENTS OF PLASMAS—APPLICATIONS OF THE UNIFIED THEORY. Yukikazu Itikawa (Tokyo Univ.). J. Phys. Soc. Japan, 18: 1499-1507 (Oct. 1963).

The electrical and thermal conductivities and the viscosity coefficient of plasmas are calculated in the unified theory with no cut-off procedure. The results are valid not only for large values of the Coulomb logarithms themselves, but also for large values of their arguments. The effect of a magnetic field is not considered. (auth)

3003 COLLISION DIFFUSION OF PLASMA IN MAGNETIC FIELD. Masumi Sato and Yoshisuke Hatta (Tohoku Univ., Sendai). J. Phys. Soc. Japan, 18: 1507-14(Oct. 1963).

An experimental and mathematical investigation of the diffusion rate of a plasma across a magnetic field lower than the critical field for screw instability indicates that there is no diffusion mechanism due to the short circuit effect and that the diffusion across the longitudinal field is ambipolar regardless of the tube dimension, in contrast to Simon's theory. A method for quantitatively determining the diffusion rate across the magnetic field from the voltage-current relation of the discharge tube in the magnetic field is presented. (auth)

3004 ION OSCILLATIONS IN A PLASMA. Shoji Kojima (Tokyo Univ.), Takaya Kawabe, Kiyoe Kato, and Kiyoshi Ogawa. J. Phys. Soc. Japan, 18: 1553-4(Oct. 1963).

The oscillation intensity in a hog-cathode mercury vapor plasma was observed as a function of discharge current. The frequency of the strongest oscillation noted increased with the discharge current and was observed simultaneously with the electron oscillation frequency. This main oscillation was identified as the ion oscillation, which proved to be unaffected by a weak magnetic field. It was also coexistent with the other large fluctuation. (D.C.W.)

3005 RADIATION SMOOTHING OF SHOCKS WITH AND WITHOUT A MAGNETIC FIELD. M. Mitchner and M. Vinokur (Lockheed Missiles and Space Co., Palo Alto, Calif.). Phys. Fluids, 6: 1682-92(Dec. 1963).

A transverse magnetic field imposed on a radiating shock wave is shown to inhibit the smoothing tendency of radiation energy transfer, and to alter the conditions for the occurrence of a temperature overshoot. Necessary and sufficient conditions for the smoothing of shocks by the mechanism of radiation energy transfer acting alone are discussed and numerical results are derived for the case of no magnetic field. A possible experimental test is proposed. (auth)

3006 CONVERGENT CLASSICAL KINETIC EQUATION FOR A PLASMA. E. A. Frieman and D. L. Book (Princeton Univ., N. J.). Phys. Fluids, 6: 1700-6(Dec. 1963).

A kinetic equation for a plasma of electrons and infinite mass ions is derived that exhibits no divergences for any impact parameter. The basic expansion used is in $n\lambda_D^3$, the number of particles in a Debye sphere. The collision operator has Boltzmann, Fokker–Planck, and Lenard–Balescu behavior in the appropriate impact parameter regimes. (auth)

3007 TIME DEPENDENCE OF THE TWO-PARTICLE CORRELATION FUNCTION IN A ONE-COMPONENT PLASMA. George L. Lamb, Jr. (Los Alamos Scientific Lab., N. Mex.). Phys. Fluids, 6: 1707-13(Dec. 1963). (LADC-5800).

The linearized equations governing the time dependence of the one-particle distribution function and the two-particle correlation function in a one-component plasma that is slightly removed from thermal equilibrium are investigated in the plasma limit. The integral equation for the two-particle correlation function is solved by the Wiener–Hopf method. It is shown that a self-consistent evolution of the one-particle distribution function and the two-particle correlation correlation function is not prescribed by the theory unless lengths on the order of the distance of closest approach in a two-body encounter are retained. The relation of the analysis to the conjecture by Bogoliubov concerning the time dependence of multiparticle distribution functions is discussed. In particular, it is shown that although modes corresponding to distances larger than the Debye length are very slowly damped they do not make an appreciable contribution to the kinetic equations. (auth)

3008 KINETIC THEORY OF PLASMA AND THE ELECTROMAGNETIC FIELD. Thomas H. Dupree (Massachusetts Inst. of Tech., Cambridge). Phys. Fluids, 6: 1714-29(Dec. 1963).

An exact kinetic equation for plasma and the electromagnetic field is derived. This equation describes the fluctuations of the fields and particle distributions. The solution is obtained by expanding in a parameter that characterizes the amplitude of these fluctuations. A systematic procedure is given for generating the solution to arbitrary order in the expansion. Some typical applications of the theory are presented. These include calculations of a collision integral, incoherent scattering, and bremsstrahlung emission and absorption. (auth)

3009 KINETIC TREATMENT OF THE STABILITY OF A RELATIVISTIC PARTICLE BEAM PASSING THROUGH A PLASMA. R. C. Mjolsness (General Electric Co., Valley Forge, Penna. and Los Alamos Scientific Lab., N. Mex.). Phys. Fluids, 6: 1730-40(Dec. 1963).

The equilibrium configuration consists of a uniform particle beam of circular cross section and infinite extent streaming at highly relativistic velocity through a uniform, dense background plasma. The plasma is characterized by a scalar conductivity, and the beam is described by a collisionless Boltzmann equation in which a two mass approximation to the relativistic dynamics was made. The stability problem for this configuration is formulated as a set of three linear, coupled integral equations for three field variables (certain Hankel transforms of the perturbed electric field), and a formal solution of the equations is obtained by iteration. The dispersion relation appears as a solvability condition. The treatment gives a full account of the betatron orbits of the beam particles. Asymptotic results are obtained for low-frequency, long-wavelength disturbances and for high-frequency, highly localized disturbances. (auth)

3010 PLASMA-BEAM INSTABILITY IN THE HARTREE-APPLETON APPROXIMATION. Jacob Neufeld (Oak Ridge National Lab., Tenn.). Phys. Fluids, 6: 1750-6(Dec. 1963).

The interaction of a beam of protons of small intensity moving with velocity $c\beta$ (where c is the velocity of light) through a stationary plasma is investigated under the assumption that the beam is aligned along the direction of an impressed static magnetic field. Expressions are derived for frequencies and rates of growth characterizing the transverse waves excited by the beam and aligned along the direction parallel to that of the impressed field. It is assumed that the frequencies of the excited waves are large when compared to the proton gyrofrequency and are sufficiently high so that the motion of the plasma ions perturbed by these waves are neglected. It is shown that two waves are simultaneously excited by a beam having velocity $c\beta < c\beta_{max}$ and a relation is obtained between β_{max} and the parameters characterizing the stationary plasma. (auth)

3011 ELECTRIC FIELD ALONG A MAGNETIC LINE OF FORCE IN A LOW-DENSITY PLASMA. Hans Persson (Royal Inst. of Tech., Stockholm). Phys. Fluids, 6: 1756-9(Dec. 1963).

Stationary states of a collisionless plasma in a narrow axially symmetric magnetic mirror field are considered. It is shown that if the electric field vanishes identically along the magnetic field, then the angular distributions of ion and electron velocities must agree at each point. In a general case, when this condition on the distributions is not fulfilled, there is an electric field parallel with the magnetic field. (auth)

3012 EXACT SOLUTION OF THE COLLISIONLESS PLASMA-SHEATH EQUATION. S. A. Self (Stanford Univ., Calif.). Phys. Fluids, 6: 1762-8(Dec. 1963).

The plasma-sheath problem for the low-pressure discharge in plane geometry is treated exactly, that is, with no arbitrary division into plasma and sheath regions. Numerical solutions are presented for various values of the parameter α, which is of the order of the ratio of the Debye length to the discharge width for $10^{-3} \leq \alpha \leq 10^{-1}$; and for three assumptions regarding the ion generation rate, namely generation uniform, proportional to electron density, and proportional to the square of electron density. For the higher values of α, corresponding to weak laboratory discharges, there is a smooth transition from a quasi-neutral plasma region to a thick sheath. At the smaller values of α, the conventional model of a quasi-neutral plasma region passing rather abruptly into a narrow sheath region is substantiated. In all cases, accurate values for the potential profile throughout the plasma and sheath regions are given and compared with the separate asymptotic plasma and sheath solutions for $\alpha = 0$. The ion current density, wall potential, space-charge density, mean ion energy, and sheath thickness are discussed. (auth)

3013 DRIFT INSTABILITIES IN CYLINDRICAL DISCHARGES. John Wesson (Associated Electrical Industries Ltd., Aldermaston, Berks, Eng.). Phys. Fluids, 6: 1769-71 (Dec. 1963).

Fluid equations are used to determine the drift stability of a general shearless cylindrical discharge. Arbitrary ion and electron temperatures are allowed. It is shown that a sufficiently large or small ratio of ion to electron temperature gives stability, and that, provided the azimuthal field is not too small, marginal magnetohydrodynamic stability implies drift stability. (auth)

3014 MAGNETO—ACOUSTIC WAVES IN A PLASMA. J. Dé (Royal Inst. of Tech., Stockholm). Phys. Fluids, 6: 1772-4(Dec. 1963).

The propagation of plane magneto-acoustic waves in a highly conducting plasma is examined, and the results are applied to magneto-acoustic pulsations of a cylindrical configuration. (C.E.S.)

3015 SPECTRAL DISTRIBUTION OF CHARGED PARTICLES IN A TURBULENT PLASMA. Harold S. Rothman, Harold Guthart, and Tetsu Morita (Stanford Research Inst., Menlo Park, Calif.). Phys. Fluids, 6: 1775-7(Dec. 1963).

An attempt was made to determine whether the spectral distribution of charged particles in a weakly ionized turbulent flow follows that of the neutral particles. An electrostatic ion probe and a microwave electron probe were used. It was found that the electron and ion fluctuations have identical spectra in the thermally produced plasma. (C.E.S.)

3016 SPECTROSCOPIC OBSERVATIONS ON A FULLY-IONIZED BARIUM PLASMA. E. Hinnov, J. G. Hirschberg, F. W. Hofmann, and N. Rynn (Princeton Univ., N. J.). Phys. Fluids, 6: 1779-80(Dec. 1963). (MATT-206)

The behavior of a low-temperature, highly ionized barium plasma was investigated. The emission spectrum in the range 3500–7000 Å consisted only of the two resonance lines of ionized barium at 4554 and 4934 Å and a trace of the neutral resonance line at 5535 Å. From the relative intensities of these lines the upper limit of the neutral barium density in the plasma was estimated as less than 0.3% of the ion density. The ion densities and temperatures were also determined. (C.E.S.)

3017 SHOCK WAVES IN A PINCHED DISCHARGE. A. Folkierski and R. Latham (Imperial Coll. of Science and Tech., London). Phys. Fluids, 6: 1780-2(Dec. 1963).

A cylindrical shock front that precedes the snowplow during the first collapses of an unstabilized linear pinched discharge was observed. The discharges were in argon at pressures ranging from 0.2 to 1.0 mm Hg. (C.E.S.)

3018 EFFECT OF CORRELATION ON THE HIGH-FREQUENCY CONDUCTIVITY OF AN ELECTRON GAS. P. A. Wolff (Bell Telephone Labs., Murray Hill, N. J.). Phys. Rev., 132: 2017-23(Dec. 1, 1963).

The equation of motion method is used to study the high-frequency conductivity of a single-component plasma in which carriers have a nonquadratic energy-momentum relation. In such a medium current is not conserved in electron-electron collisions, and there are important correlation corrections to the conductivity. The expression for the correction involves the perturbed correlation function in the plasma, and explicitly shows that the correction vanishes in the case of a quadratic energy-momentum relation. Evaluation of the correlation function is only possible if the electron-electron interaction is weak. An approximate calculation is made in this limit, which yields a formula for the conductivity that is correct to second order in the electron-electron interaction. (auth)

3019 SPECTROSCOPIC STUDY OF ELECTRON RECOMBINATION WITH MONATOMIC IONS IN A HELIUM PLASMA. Frank Robben, Wulf B. Kunkel, and Lawrence Talbot (Univ. of California, Berkeley). Phys. Rev., 132: 2363-71(Dec. 15, 1963).

Recent work on electron-ion recombination has shown that a model including recombination into highly excited bound levels through electron-electron-ion collisions and transitions between the bound levels through electron-atom collisions, as well as the usual radiative transitions, is in good agreement with experiments in which processes involving molecular ions, etc., are unimportant. By making absolute intensity measurements of the lines of helium emitted from the decaying plasma of an arc jet in the visible and near ultraviolet, the number densities of the excited states of helium were calculated. From these measurements electron temperatures between 0.15 and 0.30 ev and electron densities between 4×10^{12} and 4×10^{14} cm^{-3} are found, with a fractional ionization of the order of 1%. When interpreted by means of the collisional-radiative recombination model, these measurements also give values for $K_{n,n-1}$, the collisional deexcitation rate constant of an excited helium atom from level n to n−1. The constancy of $K_{n,n-1}$ over a range of electron density from 4×10^{12} to 4×10^{14} per cm^3 indicates the validity of the model, and the values of $K_{n,n-1}$ are in reasonable agreement with a recent theory of classical excitation cross sections. A square-root dependence of this cross section on the excess energy is indicated, since the values of $K_{n,n-1}$ appear to be independent of electron temperature. It is then found that $Q_{2,3} = 9.3 \times \sqrt{E}$, $Q_{3,4} = 73 \times \sqrt{E}$, and $Q_{4,5} = 380 \times \sqrt{E}$, where $Q_{n,n+1}$ is the averaged excitation cross section from the levels with principal quantum number n to the levels with principal quantum number n + 1 in units 10^{-15} cm^2, and E is the excess energy in ev. These cross sections have an estimated error of about 30% in the threshold energy range to about 0.3 ev. (auth)

3020 FREQUENCY SPECTRUM OF THERMAL FLUCTUATIONS IN PLASMAS. E. C. Taylor and G. G. Comisar (Aerospace Corp., Los Angeles). Phys. Rev., 132: 2379-84(Dec. 15, 1963).

The frequency spectrum of electron density fluctuations arising from thermal motions of the particles in a plasma is computed by means of an extension of Richardson's noise theory. Calculations based on the relaxation-model kinetic

equation, which is taken to represent a plasma in which the dominant collision processes are those between charged particles and neutral particles, lead to the usual collision-free results in the limit of vanishing collision frequency. For the collision-dominated plasma, this model leads to spectral widths proportional to the ion-diffusion coefficient. Calculations based on the Fokker-Planck model kinetic equation, which is taken to represent a plasma in which the dominant-collision processes are those between charged particles, lead to spectral widths which are also proportional to the ion-diffusion coefficient. (auth)

3021 A CALCULATION OF THE INSTANTANEOUS POPULATION DENSITIES OF THE EXCITED LEVELS OF HYDROGEN-LIKE IONS IN A PLASMA. R. W. P. McWhirter and A. G. Hearn (Culham Lab., Culham, Abingdon, Berks, Eng.). Proc. Phys. Soc. (London), 82: 641-54 (Nov. 1, 1963). (CLM-P23)

The instantaneous population densities for the excited levels of hydrogen-like ions in an optically thin plasma, which is not necessarily in equilibrium, were calculated for a range of electron temperature of $4{,}000Z^2$ to $256{,}000Z^2$ °K and electron density of 10^8Z^7 to $10^{18}Z^7$ cm^{-3}, where Z is the charge of the bare nucleus. The population densities depend linearly on the ground level population densities and tables are presented of two coefficients representing this relation for some of the lower excited levels. The calculations include the processes of excitation, de-excitation, ionization by electron collision, spontaneous radiative decay, three-body recombination, and radiative recombination. Processes involving the absorption of photons are neglected, and it is assumed that the free electrons have a Maxwellian distribution. The validity of the calculations in the extremes of the ranges is discussed. The calculations illustrate the transition from high densities where all the excited levels have nearly a Saha-Boltzmann population to low densities where the radiative capture-cascade model is valid. From the population density of the excited levels, the power lost by line radiation by hydrogen-like ions, radiative recombination of electrons onto the bare nuclei and bremsstrahlung of the free electrons in the field of the bare nuclei is calculated. Since energy is lost by radiation, the total energy dissipated during the ionization of one hydrogen-like ion may be much greater than the simple ionization energy of the ion. This was calculated for electron temperatures between $16{,}000Z^2$ and $256{,}000Z^2$ °K. (auth)

3022 LONGITUDINAL ELECTROSTATIC OSCILLATIONS IN VELOCITY-GRADIENT PLASMAS. I. THE SLIPPING-STREAM MODEL. E. R. Harrison (Rutherford High Energy Lab., Chilton, Berks, Eng.). Proc. Phys. Soc. (London), 82: 689-99(Nov. 1, 1963).

Electrostatic oscillations in velocity-gradient plasmas are studied with the aid of two simplifying models: the slipping-stream model; and the adjacent-stream model. The slipping-stream model is considered. In the simplest slipping-stream plasma the mean longitudinal velocity u, parallel to the z axis, varies linearly in a transverse direction. Various assumptions are made in the treatment: collisions are neglected; it is assumed that a longitudinal magnetic field is sufficiently intense to suppress transverse oscillatory electron motions; it is assumed that the boundaries are sufficiently conducting for the electric potential to vanish at these boundaries; and finally only electron electrostatic interactions are considered. It is first shown that in the case of a zero-temperature slipping stream, longitudinal electron oscillations are stable, in the sense that there are no modes that are exponentially time-growing, when $\omega_e^2/\alpha^2 < 1/4$, where ω_e is the electron plasma frequency. When the longitudinal velocity u is an arbitrary function of the transverse coordinate x, general considerations show that $\omega_e^2 < 1/4(du/dx)^2_{max}$ is a sufficient condition for stability, where $(du/dx)^2_{max}$ is the maximum value of the velocity gradient squared in the stream. It is then shown that in the case of a finite temperature the slipping stream has increased stability and larger velocity gradients are necessary to cause instability. (auth)

3023 LONGITUDINAL ELECTROSTATIC OSCILLATIONS IN VELOCITY-GRADIENT PLASMAS. II. THE ADJACENT-STREAM MODEL. E. R. Harrison (Rutherford High Energy Lab., Chilton, Berks, Eng.) and T. E. Stringer. Proc. Phys. Soc. (London), 82: 700-9(Nov. 1, 1963).

In the adjacent-stream model the mean longitudinal velocity, parallel to the z axis, is u_1 in the range of $-a_1 \leq x < 0$, and u_2 in the range $0 < x \leq u_2$. The assumptions made are similar to those used previously in the treatment of the slipping-stream model. When the adjacent streams are of zero temperature it is shown that there are longitudinal electron oscillations that are exponentially time-growing, and the system is therefore always unstable. A general stability criterion is then derived for arbitrary but preferably single-humped distribution functions. However, the determination of the stability conditions for given distribution functions presents some difficulty, and in the particular case of Maxwellian distributions an alternative but approximate method is used. It is shown that there is stability for all velocity differences between the two streams when the transverse dimensions are comparable with, or less than, the Debye length, or when the velocity difference is comparable with, or less in magnitude than, the characteristic thermal speed of the electrons. (auth)

3024 ON COLLISIONLESS SHOCK WAVES IN PLASMA. R. V. Polovin (Khar'kov Inst. of Physics and Tech.). Ukr. Fiz. Zh., 8: 830-4(Sept. 1963). (In Russian)

Starting from the affirmation of the ergodical structure of a shock wave in a collisionless plasma immersed in a magnetic field the lengths of dissipation and of isotropization of the pressure tensor are estimated. The rise of the ion temperature exceeds that of the electrons. If the magnetic and hydrostatic pressures have the same order of magnitude, the dissipation takes place within the Debye length for shock waves of moderate strength. The pressure tensor becomes isotropic within the Larmor radius of the ion. (auth)

3025 SPATIALLY GROWING ELECTROSTATIC TURBULENCE. William E. Drummond (General Atomic Div., General Dynamics Corp., San Diego, Calif.). 23p. (CONF-78-17; GA-3809)

From American Physical Society 1963 Summer Meeting, Buffalo, June 1963.

The non-linear theory has been extended to spatially growing plasma oscillations in a bounded plasma, and it is shown that at large distances this leads to a stationary turbulent electrostatic spectrum. A novel feature appears in that the gradient of the longitudinal radiation pressure leads to a charge separation and consequently to a d-c electrostatic field in the region in which the turbulence is growing. (auth)

3026 COLLECTIVE MOTION OF AN ELECTRON OR ION GAS AT MULTIPLES OF THE CYCLOTRON FREQUENCY. J. R. Johnston and Richard L. Moore (Douglas Aircraft Co., Inc., Long Beach, Calif.). 8p. (CONF-78-18)

From American Physical Society 1963 Summer Meeting, Buffalo, June 1963.

An explanation is given for phenomena found in laboratory plasmas. When a magnetic field is present, either the ion component or the electron component (but not both simultaneously) may rotate with a mean angular velocity equal to its cyclotron frequency. In such a case, the periodic electric and magnetic force fields induced by certain types of collective oscillations of the velocity field cooperate in such a way that rotating wave patterns are formed. These rotating waves fall into two groups. The frequency of the first group is the well-known plasma frequency. The second group has two frequencies—one near a multiple of the cyclotron frequency, and the other, much lower, at the square of the plasma frequency divided by a multiple of the cyclotron frequency. The field of motion of the first group of waves is periodic along the direction of the magnetic field. The field of motion for the second group of waves is given. These fields of motion are in agreement with experiments in which it is found that the higher harmonics of the cyclotron frequency can be excited to a much higher degree than theory predicts. (auth)

3027 MICROWAVE INTERACTIONS WITH INHOMOGENEOUS PARTIALLY IONIZED PLASMA. A. H. Kritz (General Dynamics/Astronautics, San Diego, Calif.). 29p. (CONF-288-1; AD-296044)

From 2nd Conference on Kinetics Equilibria and Performance of High Temperature Systems, Western States Section of the Combustion Inst., Los Angeles, Apr. 1962.

Microwave interactions with inhomogeneous plasmas are often studied by employing a simplified electromagnetic approach, i.e., by representing the effects of the plasma by an effective dielectric coefficient. The problems and approximations associated with this procedure are discussed. The equation describing the microwave field in an inhomogeneous partially ionized plasma is derived, and the method that is applied to obtain the reflected, transmitted, and absorbed intensities in inhomogeneous plasmas is presented. The interactions of microwaves with plasmas having Gaussian electron density profiles are considered. The variation of collision frequency with position is usually neglected. In general, the assumption of constant collision frequency is not justified; e.g., for a highly ionized plasma, the electron density profile determines, in part, the profile of the electron-ion collision frequency. The effect of the variation of the collision frequency profile on the interaction of microwaves with inhomogeneous plasmas is studied in order to obtain an estimate of the degree of error that may result when constant collision frequency is assumed instead of a more realistic collision frequency profile. It is shown that the degree of error is of particular importance when microwave analysis is used as a plasma diagnostic. (auth)

3028 GAS DISCHARGE APPARATUS. Peter Clive Thonemann (to United Kingdom Atomic Energy Authority). U. S. Patent 3,109,801. Nov. 5, 1963. Priority date June 20, 1957, Great Britain.

A gas discharge apparatus is described for research in the production of controlled thermonuclear reactions. The apparatus comprises a metal torus with two circumferential insulating gaps and a liner for shielding the gaps from the discharge, and means for establishing a ring discharge within the torus. The liner is electrically continuous around its large circumference and has a resistance around the same circumference which is large compared with the discharge resistance. The liner preferably consists of corrugated stainless steel. The cooling arrangements of the torus are described. (D.L.C.)

Shielding

3029 (RISO-62) DETERMINATION OF THE ABSORPTION CURVE IN WATER OF Co^{60} γ RAYS AND DETERMINATION OF THE STRENGTH OF A 6 CURIE Co^{60} SOURCE BY MEANS OF FERROUS-SULPHATE DOSIMETRY. Knud Sehested, Ari Brynjolfsson, and Niels W. Holm (Denmark. Atomenergikommissionen. Forsøgsinstitut, Risø). May 1963. 28p.

The γ build-up factors in water are calculated for an isotropic Co^{60} point source by interpolation from results obtained on the basis of the moment method. The Fricke dosimeter is applied for experimental checks on these calculations, because this system is almost water-equivalent and gives a minimum of perturbation to the irradiation field. The source strength is determined by means of 1-, 2-, and 10-liter flasks encircling the source, and the absorption curve is derived from dose determination in ampoules of different types. The theoretical and experimental results are found to agree. (auth)

3030 EXPERIMENTAL AND THEORETICAL STUDIES ON THE RELATIVE BIOLOGICAL EFFECTIVENESS OF NEUTRONS. I. A TESTED SHIELD FOR A NEUTRON GENERATOR. E. H. Graul, H. Krueger, and H. Hundeshagen (Phillipps-Universität, Marburg/Lahn, Ger.). Atompraxis, 9: 389-95(Oct. 1963). (In German)

Experiences in constructing a shielded bunker for a neutron generator with a source strength of ca 2×10^{10} 14-Mev neutrons per second are described. Special consideration is given to the projecting of the bunker and the dose-output values measured outside the shielded area. A list of cost factors for the shielding is also included. (P.C.H.)

3031 A MONTE CARLO METHOD FOR CALCULATING THE PENETRATION AND ENERGY DEPOSITION OF GAMMA RADIATION FROM DISTRIBUTED SOURCES IN LAMINATED SHIELDS. Martin Leimdoerfer (Research Inst. of National Defense, Stockholm). Trans. Am. Nucl. Soc., 6: 427-8(Nov. 1963).

3032 EXPERIMENTAL MEASUREMENTS OF SECONDARY-GAMMA-RAY PRODUCTION IN SHIELDING MATERIALS. R. Schamberger, J. Celnik, and R. Ross (United Nuclear Corp., White Plains, N. Y.). Trans. Am. Nucl. Soc., 6: 428-9(Nov. 1963).

3033 APOLLO RADIATION SHIELDING ANALYSIS: PART I. BASIC PHYSICS DATA, GEOMETRY, AND PROTON SOURCE INFORMATION. R. A. Blaine and H. Alter (Atomics International, Canoga Park, Calif.). Trans. Am. Nucl. Soc., 6: 431(Nov. 1963).

3034 APOLLO RADIATION SHIELDING ANALYSIS: PART II. A PROGRAM TO CALCULATE THE PENETRATION OF PRIMARY AND SECONDARY RADIATIONS IN THE APOLLO GEOMETRY. K. L. Rooney, W. J. Roberts, and R. S. Hubner (Atomics International, Canoga Park, Calif.). Trans. Am. Nucl. Soc., 6: 432(Nov. 1963).

3035 UMBRELLA-TYPE SHIELDING FOR SOLAR-FLARE PROTONS. T. L. Aggson (Republic Aviation Corp., Farmingdale, N. Y.). Trans. Am. Nucl. Soc., 6: 432-3(Nov. 1963).

3036 COMPUTER CALCULATION OF DOSE RATES IN TWO-LEGGED DUCTS USING THE ALBEDO CONCEPT. J. M. Chapman (Naval Civil Engineering Lab., Port Hueneme, Calif.). Trans. Am. Nucl. Soc., 6: 437(Nov. 1963).

3037 DEPENDENCE OF DOSE BUILDUP ON THE POSITION OF A STEEL SLAB PLACED BETWEEN A POINT SOURCE AND A POINT DETECTOR. G. E. Langer and B. W. Shumway (Naval Radiological Defense Lab., San Francisco). Trans. Am. Nucl. Soc., 6: 437-8(Nov. 1963).

REACTOR TECHNOLOGY

General

Refer also to abstracts 2182 and 2403.

3038 (ANL-6801) REACTOR DEVELOPMENT PROGRAM PROGRESS REPORT, OCTOBER 1963. (Argonne National Lab., Ill.). Nov. 15, 1963. Contract W-31-109-eng-38. 84p.

Research and development progress is reported on BORAX-V, fast-reactor physics, fast-reactor fuel, EBR-II, FARET, applied nuclear physics, theoretical nuclear physics, reactor fuels, reactor materials, metallurgy α-γ hot cell, heat engineering research, chemical separations, plutonium recycle program, magnetohydrodynamics, rocket fuel test reactor, nuclear safety, and TREAT. (M.C.G.)

3039 (APDA-151) TWO-FACILITY APPROACH TO INVESTIGATIONS OF FAST REACTOR MELTDOWNS. T. A. Doyle, R. B. Nicholson, J. B. Nims, E. M. Page, and J. T. Hagstrom (Atomic Power Development Associates, Inc., Detroit). Jan. 15, 1963. Contract AT(11-1)-865. 165p.

The technical feasibility of conducting fast reactor meltdown experiments to determine a more realistic maximum accident and to provide a better evaluation of fast reactor safety was investigated. One- and two-facility approaches are discussed. Topics covered include: design and operational aspects of facility, interpretation of experiments, instrumentation, safety considerations, research and development, and preliminary cost estimates. (M.C.G.)

3040 (IITRI-A6042-2) STUDIES OF REACTOR CONTAINMENT. Bimonthly Progress Report, June–July 1963. E. V. Gallagher (Illinois Inst. of Tech., Chicago. IIT Research Inst.). Contract AT(11-1)-578. 38p.

Progress is reported on crushable shield analysis and design, shock impingement experiments on crushable shields, and coolant decompression experiments and analysis. A comparison is made of computer codes for calculation of wave transmission in layered composites of crushable materials. Experiments and techniques for determining unloading isentrope relations for balsa wood in the shock tube test facility are evaluated. High speed photography is being used to analyze the initial flow development following sudden decompression of water from pressure vessels. A description of equipment for studying coolant decompression is given. (N.W.R.)

3041 (SPM-710) NOUVELLE EXPRESSION SIMPLE DU COEFFICIENT DE DIFFUSION RADIAL POUR DES CANAUX CHARGES DE BARRES COMBUSTIBLES. (A Simple New Expression for the Radial Diffusion Coefficient for Fueled Channels). P. Benoist (France. Commissariat à l'Énergie Atomique. Centre d'Études Nucléaires, Saclay). Jan. 20, 1962. 25p.

A method of approach is proposed that will allow a simple formula for the radial diffusion coefficient of fueled channels to be established. As the problem of the calculation of the radial diffusion parallels that of the thermal utilization factor, a similar line of study was used in the solution. In the calculation of the perturbation induced by vacuum channels, the simple formulas established by Carter and Leslie were introduced. (J.S.R.)

3042 (SRIA-113) CONTAINMENT OF FRAGMENTS FROM A RUNAWAY REACTOR. Technical Report No. 6. R. W. White and N. B. Botsford (Stanford Research Inst., Menlo Park, Calif.). Contract AT(04-3)-115. 33p.

In previous experiments on the penetration of thin steel plates by cylindrical tool steel rods, an empirical formula was developed for describing the results. Subsequent experiments were performed to investigate the effects of scale size and prestress of the target, and penetration by concrete projectiles. The scaling experiments show that scaling is valid over a size range of 7 to 1. Concrete projectiles containing iron shot aggregate were found to require greater energy for penetration than ordinary concrete projectiles. Penetration resistance to tool steel missiles is reduced for target plates having less than 3000 psi or more than 6000 psi initial tension, and a physical model is given for correlating these results. Fragmentation data from concrete models are analyzed. (D.L.C.)

3043 (TID-19678) DOSIMETRY OF REACTOR RADIATION FROM THE SHIELD TEST POOL FACILITY. Report No. 22. K. L. Hall, M. W. Tobriner, M. A. Sweeney, J. A. Dubay, R. F. Klaver, and R. O. Bolt (California Research Corp., Richmond). June 30, 1963. Contract AT(04-3)-248. 156p.

Includes Appendices.

The neutron and gamma dose rates in the radiation were determined separately by using a series of polyphenyl and metal calorimeters with varying neutron to gamma responses. The neutron spectra, required by the analysis method, were derived both theoretically from reactor physics and empirically by the foil activation method. The results are expressed by an equation interrelating the neutron and gamma heating rates as a function of positron within each of two canisters, one for exposures to fast-neutron rich and the other to gamma-rich radiation. (auth)

3044 (AEC-tr-5640) CONSTRUCTION OF NUCLEAR INSTALLATIONS. A. N. Komarovskii. Translation of "Stroitel'stvo Yadernykh Ustanovok" (a publication of the State Publishing House of Power Literature, Moscow, Leningrad, 1961). 594p.

Issued in two books.

This book is an attempt to generalize and analyze the experience gained in the structural design and construction of stationary atomic installations both in USSR and abroad. Some of the more successful construction solutions are evaluated, and opinions are presented which were tested by practical experience. Radiation shielding, siting of reactors, containment shells, and installation operations are considered. (D.L.C.)

3045 STUDY OF THE EXPLOSION OF A FORCE TUBE IN A NUCLEAR REACTOR. R. Lemaitre and A. Peuchmaur. Energie Nucl., 5: 355-71(July-Aug. 1963). (In French)

The study presented concerns the El-4 Reactor, moderated by heavy water and cooled by carbon dioxide under pressure, for which the force tube system was adopted. The tank serves as the heavy water container. The evolution of pressures and temperatures resulting from the bursting of a tube was determined. After a detailed presentation of theoretical studies, the tests made on a scale model are described and the results obtained are discussed. The application of these results to the calculation of the resistance of tank materials was considered. (tr-auth)

3046 PRECISION LIMITATIONS IN THE MEASUREMENT OF SMALL REACTIVITY CHANGES. Edgar F. Bennett and Robert L. Long (Argonne National Lab., Ill.). Nucl. Sci. Eng., 17: 425-32(Nov. 1963).

Expected errors in reactivity measurements made with a servo control are discussed and compared with observation. The influence upon measurement statistics of a residual spurious reactivity drift, of variable detector efficiency, and of servo control parameters was examined and compared with results using a thermal reactor at 72 watts. Power limited precision is shown to be obtainable with a servo control over a broad range of operating configurations and with good discrimination against incoherent residual reactivity drift. (auth)

3047 ON THE DETERMINATION OF THE TRANSFER FUNCTION THROUGH A "NONLINEAR" MEASUREMENT. Dusan Babala (Institutt for Atomenergie, Kjeller, Norway). Nucl. Sci. Eng., 17: 498(Nov. 1963).

It is pointed out that the transfer function of a zero power reactor can be determined by measuring the first two harmonics of the reactor response to a sinusoidal reactivity variation of arbitrary amplitude. (P.C.H.)

3048 TRANSACTIONS OF THE AMERICAN NUCLEAR SOCIETY REACTOR OPERATIONS DIVISION MEETING, OCTOBER 21-23, 1963, OTTAWA, ONTARIO. Problems of Operating Research and Power Reactors. Malcolm D. Ferrier, ed. Trans. Am. Nucl. Soc., 6: Suppl., 1-52(Oct. 1963).

Summaries of seventy-three papers presented at this Conference are included in the Proceedings. Titles of sixty eight of the papers are give separately. Five of the papers were previously abstracted in NSA. (L.T.W.)

For titles of individual summaries see: 1979, 2272, 2273, 3049, 3050, 3051, 3052, 3053, 3054, 3055, 3056, 3057, 3058, 3072, 3073, 3074, 3075, 3076, 3077, 3078, 3079, 3080, 3157, 3267, 3268, 3269, 3270, 3271, 3272, 3273, 3274, 3275, 3276, 3277, 3278, 3279, 3280, 3281, 3289, 3290, 3357, 3358, 3359, 3360, 3361, 3362, 3363, 3364, 3365, 3366, 3367, 3368, 3369, 3370, 3371, 3372, 3373, 3374, 3375, 3376, 3377, 3378, 3379, 3380, 3381, 3382, 3383, and 3384.

3049 THE EDUCATION, TRAINING, QUALIFICATION, AND EXPERIENCE OF REACTOR OPERATORS AT AEC-OWNED REACTORS. Whittie J. McCool, Walter S. Wilgus, and Martin B. Biles (Atomic Energy Commission, Washington, D. C.). Trans. Am. Nucl. Soc., 6: Suppl., 19(Oct. 1963).

3050 SELECTION OF PERSONNEL FOR REACTOR OPERATOR TRAINING. Frederick H. Martens (Argonne National Lab., Ill.). Trans. Am. Nucl. Soc., 6: Suppl., 19-20(Oct. 1963).

3051 OPTIMIZING PERSONNEL UTILIZATION AND ADVANCEMENT WITH ANOMALOUS EMPLOYEE PRACTICES AND PROCEDURES. Bruce W. Link (Ames Lab., Ames, Iowa). Trans. Am. Nucl. Soc., 6: Suppl., 23-4(Oct. 1963).

3052 REGULATORY INTEREST IN OPERATION. F. C. Boyd and J. H. Jennekens (Atomic Energy Control Board, Ottawa). Trans. Am. Nucl. Soc., 6: Suppl., 25(Oct. 1963).

3053 REACTOR SAFETY REVIEWS BY THE REACTOR MANAGER. Douglas E. Ericson (U. S. Atomic Energy Commission, Argonne, Ill.). Trans. Am. Nucl. Soc., 6: Suppl., 28(Oct. 1963).

3054 THE REACTOR SAFEGUARDS REVIEW PROGRAM AT ATOMICS INTERNATIONAL. Marlin E. Remley (Atomics International, Canoga Park, Calif.). Trans. Am. Nucl. Soc., 6: Suppl., 28-9(Oct. 1963).

3055 OBTAINING REACTOR OPERATING PARAMETERS FROM INTERPRETATION OF THE POWER SPECTRUM OF REACTOR NOISE. N. Barrie McLeod (Nuclear Utility Services, Inc., Washington, D. C.). Trans. Am. Nucl. Soc., 6: Suppl., 31-2(Oct. 1963).

3056 ANALYSIS OF PERIOD-INSTRUMENTATION OPERATION AT FULL REACTOR POWER. Kenneth A. McCollom (Ames Lab., Ames, Iowa). Trans. Am. Nucl. Soc., 6: Suppl., 32-3(Oct. 1963).

3057 EXTENDING REACTOR TIME-TO-POISON BY PRE-SHUTDOWN POWER ALTERATIONS. Edward Kerr (Atomic Energy of Canada Ltd., Chalk River, Ont.). Trans. Am. Nucl. Soc., 6: Suppl., 39-40(Oct. 1963).

3058 A LARGE-VOLUME, CONTINUOUS GAS-EFFLUENT MONITORING SYSTEM. Donald E. Feltz (Texas A & M, College Station). Trans. Am. Nucl. Soc., 6: Suppl., 52(Oct. 1963).

3059 BOILING-WATER REACTORS: WATER CHEMISTRY. p.92-6 of "Power Reactor Technology. Vol. 6, No. 4."

The second of a series of three state-of-the-art reports on the technology of boiling-water reactors prepared by Argonne National Lab., covers Water Chemistry and Corrosion. A brief discussion is presented of some of the more interesting portions of this report. (D.L.C.)

Auxiliaries and Components

Refer also to abstract 2033.

3060 (GAMD-4238) CYCLE ANALYSIS—TURBOCIRCULATOR FOR TARGET. J. Yampolsky and G. B. Melese (General Atomic Div., General Dynamics Corp., San Diego, Calif.). May 9, 1963. Contract AT(04-3)-167. 33p.

The turbocirculator, consisting of a compressor and turbine operating on a Brayton cycle, is for the circulation of coolant in a high-temperature gas-cooled reactor. An analysis is made of the range of conditions required to effect the circulation by the turbocirculator. The relationships between the parameters governing the performance of turbocirculator and reactor plant are given for turbomachine efficiencies of 0.85 and 0.90. The variations of the ratio of pumping power to reactor power are shown as a function of compressor pressure ratio for various values of the ratio of reactor outlet temperature to compressor inlet temperature. The reactor temperature rise ratio is also shown as a function of compressor pressure ratio. It is concluded that the other components of the plant, steam cycle, steam generator, and reactor temperatures can be optimized without compromise as to the turbocirculator. (D.L.C.)

3061 (GEAP-4286) IN-CORE INSTRUMENTATION DEVELOPMENT PROGRAM. TELEMETERING TRANSMITTERS FOR IN-CORE POWER MONITORING. Final Report. A. H. McQueen (General Electric Co. Atomic Power Equipment Dept., San Jose, Calif.). July 1963. Contract AT(04-3)-189. 68p.

Discussed are the development work conducted during a planned program directed toward the development of high temperature, nuclear radiation resistant, telemetering devices. The development program is devoted to: (1) investigation and selection of two possible telemetering devices, an electromechanical commutating switch and an

AM oscillator employing TIMM circuit elements, (2) procuring the electromechanical commutating switch to specification, (3) building and operating a TIMM oscillator, and (4) temperature testing of both devices. A resistance-coupled Wien-bridge sine wave TIMM oscillator was built and tested both as an oscillator, and in combination with other oscillators to simulate a telemetering system. An electromechanical commutating switch rated for 350°F operation, instead of 700°F as originally specified, was procured and tested. The drive motor and gear reduction unit which is designed to drive the commutating switch, is rated for 750°F operation and designed to operate in a nuclear reactor radiation environment of 1×10^{17} nvt and 1×10^{10} r. (auth)

3062 (KR-51) THE "KJELLER MODEL" FOR THE DYNAMICS OF COOLANT CHANNELS IN BOILING WATER REACTORS. PART I. THEORY. K. O. Solbert (Norway. Institutt for Atomenergi, Kjeller). Aug. 1963. 45p. (CONF-309-1)

From EAES Symposium on Two Phase Flow Steady State Burnout and Hydrodynamic Instability, Studsvik, Sweden, Oct. 1963.

A method is described for investigating the dynamic behavior of void and flow in boiling channels. The approach is based upon the conservation principles of mass, energy, and momentum. The momentum equation is solved in integral form around the circulation path, thus eliminating local pressures. The space and time varying void and flow are determined by solving the equations in a number of axial sections into which the coolant channel is divided. Semiempirical steady state laws, relating steam velocity and two-phase friction to local void fraction and water velocity, are used. A method is presented of taking into account boiling in subcooled water where a constant fraction of the heat flux is assumed to cause evaporation. The model is linearized and thus valid for small perturbations from a steady state. It is used to establish stability limits or to determine transfer functions as power-to-void, void reactivity, or circulation velocity. (auth)

3063 (LADC-6050) DEVELOPMENT OF UHTREX GAS-BEARING COMPRESSORS. W. E. Crowe (Los Alamos Scientific Lab., N. Mex.) and Hans Schwarz (Mechanical Technology Inc., Latham, N. Y.). [1963]. Contract W-7405-eng-36. 11p. (CONF-251-3)

From Rotating Machinery for Gas Cooled Reactor Application, Gatlinburg, Tenn., Nov. 1963.

Two helium blowers operating on hydrodynamic gas bearing and suitable for highly contaminated systems are described. The cleanup loop blower easily met its design conditions (15-psi pressure rise at 120 lb/hr), as did the main loop blower (8 psi at 10,250 lb/hr). Hydrostatic journal bearings raise the rotor assembly to avoid wear during starting and stopping. (D.C.W.)

3064 (PWAC-383) DESIGN SUMMARY REPORT OF LCRE PRIMARY COOLANT PUMPS AND SUMP. C. Ferguson, L. K. Knudsen, R. P. Lamers, B. R. Lucas, D. V. Manfredi, and H. P. Odom (Pratt and Whitney Aircraft Div., United Aircraft Corp. Connecticut Aircraft Nuclear Engine Lab., Middletown). Nov. 22, 1963. Contract AT(30-1)-2789. 54p.

Presented is a design summary report on a lithium pump and sump unit designed by Pratt & Whitney Aircraft. This report covers all work accomplished in the design phase, including analytical design studies. The subject pump (designated LP-1) was designed during the Aircraft Nuclear Propulsion (ANP) development program as a ground test reactor coolant pump to circulate lithium at 1600°F for 1000 hours. The LP-1 pump incorporated the design features of a flight type reactor coolant pump for a nuclear aircraft powerplant. After cancellation of the ANP Program, the LP-1 pump and sump unit was designated for use in the Lithium Cooled Reactor Experiment (LCRE) to operate at a reduced temperature of 1000°F for 10,000 hours without maintenance. The LP-1 pump design was based on current state-of-the-art concepts and was guided by experience gained in earlier, high temperature liquid metal pump design and development efforts. All components in contact with lithium are fabricated of Nb-1 Zr alloy, whereas the remaining components are predominantly type 316 stainless steel. (auth)

3065 (WCAP-2211) HOT CHANNEL FACTORS FOR FLOW DISTRIBUTION AND MIXING IN CORE THERMAL DESIGN. L. S. Tong, H. Chelemer, and E. A. McCabe, Jr. (Westinghouse Electric Corp. Atomic Power Dept., Pittsburgh). Feb. 1963. 20p.

The application of engineering hot channel factors to the reactor thermal design was analyzed with flow mixing. Two computer codes for evaluating the enthalpy rise in a hot channel of a reactor core were adapted; THINC-1 is used for evaluating the hot assembly factor, and THINC-II is used for the hot cell factor within an assembly. Both codes consist of the equations to account for the flow redistribution and mixing from the hot channel. Hence, they give a more realistic enthalpy rise prediction than the previous techniques. (auth)

3066 DEPOSITION OF FISSION PRODUCTS FROM HELIUM GAS STREAMS FLOWING AT HIGH VELOCITIES. A. Abriss, R. A. Ewing, and D. N. Sunderman (Battelle Memorial Inst., Columbus, Ohio). Trans. Am. Nucl. Soc., 6: 263-4(Nov. 1963).

3067 FISSION-PRODUCT DEPOSITION IN A TURBULENT AIR STREAM. T. D. Roberts (General Electric Co., Cincinnati). Trans. Am. Nucl. Soc., 6: 264-5(Nov. 1963).

3068 SOME MATHEMATICAL MODELS OF FISSION-PRODUCT DEPOSITION AND THE CORRELATION OF EXPERIMENTAL DATA. G. E. Raines (Battelle Memorial Inst., Columbus, Ohio). Trans. Am. Nucl. Soc., 6: 265(Nov. 1963).

3069 REACTIVITY WORTHS OF PROTOTYPE CONTROL RODS. W. P. Kovacik and H. Aisu (Westinghouse Electric Corp., Pittsburgh). Trans. Am. Nucl. Soc., 6: 305(Nov. 1963).

3070 THE SAXTON EXPERIMENT ON CHEMICAL SHIM CONTROL. S. Bartnoff (Westinghouse Electric Corp., Pittsburgh), J. Weisman, A. J. Impink, W. H. Layman, and D. E. Hetrick. Trans. Am. Nucl. Soc., 6: 305-6(Nov. 1963).

3071 DEVELOPMENT OF UNCANNED GRAPHITE ELEMENTS FOR OPEN POOL REACTORS. P. Thurlow, J. Saldick, and C. Arndt (AMF Atomics, Greenwich, Conn.). Trans. Am. Nucl. Soc., 6: 354(Nov. 1963).

3072 REACTOR MECHANICAL MAINTENANCE PROBLEMS. D. K. Marshall (Atomic Energy of Canada Ltd., Chalk River, Ont.). Trans. Am. Nucl. Soc., 6: Suppl., 4-5(Oct. 1963).

3073 A SYSTEM FOR MEASUREMENT OF WALL THICKNESS OF CORRODED ALUMINUM REACTOR PROCESS TUBES. Ralph V. Dulin (General Electric Co., Richland, Wash.). Trans. Am. Nucl. Soc., 6: Suppl., 5(Oct. 1963).

3074 PRESSURE-TUBE INSPECTIONS IN-PILE. H. P. Koehler (Hawker Siddeley Canada Ltd., Chalk River, Ont.) and P. A. Ross-Ross. Trans. Am. Nucl. Soc., 6: Suppl., 6(Oct. 1963).

3075 OPERATIONAL CONTROL-ROD REACTIVITY WORTHS FROM OBSERVED HEAT-GENERATION RATES. J. R. Fredsall and C. E. Bowers (General Electric Co., Richland, Wash.). Trans. Am. Nucl. Soc., 6: Suppl., 8 (Oct. 1963).

3076 BOILING IN REACTORS: ITS DETECTION AND QUENCHING BY PERIOD METERS. W. H. McCorkle (Ames Lab., Ames, Iowa). Trans. Am. Nucl. Soc., 6: Suppl., 16-17 (Oct. 1963).

3077 SELF-POWERED NEUTRON DETECTORS. J. W. Hilborn (Atomic Energy of Canada Ltd., Chalk River, Ont.). Trans. Am. Nucl. Soc., 6: Suppl., 33-4 (Oct. 1963).

3078 STEADY-STATE AND TRANSIENT POWER-LEVEL MONITORING OF A MOVABLE CORE WITH VARIABLE DETECTOR ENVIRONMENT. A. H. Kazi, G. H. Eggers, G. R. Hopkins, and J. R. Shoptaugh (General Atomic Div., General Dynamics Corp., San Diego, Calif.). Trans. Am. Nucl. Soc., 6: Suppl., 34-5 (Oct. 1963).

3079 AN IN-CORE FAILED-FUEL LOCATION AND MONITORING SYSTEM FOR BOILING-WATER REACTORS. R. N. Osborne (General Electric Co., Pleasanton, Calif.). Trans. Am. Nucl. Soc., 6: Suppl., 50 (Oct. 1963).

3080 A CLADDING-FAILURE MONITOR FOR LIQUID-METAL-COOLED REACTOR SYSTEMS. R. R. Smith and C. B. Doe (Argonne National Lab., Idaho Falls, Idaho). Trans. Am. Nucl. Soc., 6: Suppl., 50-1 (Oct. 1963).

3081 INSTRUMENTATION AND CONTROL OF NUCLEAR REACTORS. Basil Fozard. London, Iliffe Books Ltd., 1963. 181p. 38s 6d.

The fundamental problem of radiation detection is considered and various types of detectors and methods of operation are described. Ionization detectors, ionization chambers, proportional counters, Geiger-Mueller counters, and scintillation counters are discussed. Counting statistics, scaling circuits, ratemeters, pulse-counting systems, and mean current instruments are also considered. Reactor kinetics and control and the application of the various instruments and techniques in reactor instrumentation schemes are discussed. (C.E.S.)

3082 A NEW HYDRAULIC CONTROL-ROD ACTUATOR FOR NUCLEAR-REACTOR POWER PLANTS. Frank C. Legler (Atomic Energy Commission, Washington, D. C.) and Russell B. Hussey. New York, American Society of Mechanical Engineers, 1963, Preprint Paper 63-WA-88, 9p, $1.00. (CONF-102-10)

From American Society of Mechanical Engineers 1963 Winter Meeting, Philadelphia, Nov. 1963.

The hydraulic actuator satisfactorily proves the principle and its ability to satisfy the stipulated technical requirements and essential characteristics. Some of its capabilities are as follows: operating speeds are controllable within narrow limits; operation is smooth; there is little or no drift in the positioning components of the mechanism; there is positive indication of control-element position at all times; if a malfunction should occur, the actuator will either scram or "freeze" in a stationary position; scram will occur in the event of a power failure; snubbing action is provided to absorb the kinetic energy of the control element at the end of a scram; there are no dynamic seals; the actuator scrams within 1 sec; it is slightly less than 14 in. dia; it is designed to operate under environmental conditions of 2500 psig water at 650°F; and it has a wide range of load-lifting capability, and is considered to be simple in design and operation. (auth)

3083 REACTOR-VESSEL DESIGN CONSIDERING RADIATION EFFECTS. L. Porse (Westinghouse Electric Corp., Pittsburgh). New York, American Society of Mechanical Engineers, 1963, Preprint Paper 63-WA-100, 6p. (CONF-102-7)

From American Society of Mechanical Engineers 1963 Winter Meeting, Philadelphia, Nov. 1963.

Changes in metal properties resulting from fast-neutron irradiation are considered. Precautions and design steps that can cope with these radiation effects and ensure safe operation of PWR closed-cycle-type reactor vessels for their planned life expectancy are outlined. Illustrations show workable stress levels as a function of temperature for the reactor-vessel material in nonirradiated and irradiated condition. A plot of equivalent pressure-temperature relation is shown as a guide for the plant operator during plant start-up and shutdown periods. (auth)

3084 IMPROVEMENTS IN OR RELATING [TO] NUCLEAR REACTOR CORE STRUCTURES. John Lawrence Head (to General Electric Co., Ltd.). British Patent 941,781. Nov. 13, 1963. Filed Oct. 19, 1961.

A moderator structure that permits the bottom blocks of the moderator columns to tilt from the vertical under horizontal movement of the columns (in an earthquake, for instance) is described. (D.C.W.)

3085 IMPROVEMENTS IN OR RELATING TO NUCLEAR REACTOR CORE STRUCTURES. Alan Henry Butler, Harry Cox, and Roy Ronald Oxlade (to General Electric Co., Ltd.). British Patent 941,782. Nov. 13, 1963. Filed Oct. 19, 1961.

A core structure in which vertical coolant channels in vertical columns of moderator blocks can withstand misalignment of the blocks without loss of fluid (gas)-tightness is described. (D.C.W.)

3086 DEVICES FOR THE AUTOMATIC MONITORING OF THE VARIATIONS OF A PHYSICAL MAGNITUDE AT A MULTIPLICITY OF DISTINCT POINTS AND IN PARTICULAR FOR DETECTING CAN LEAKS IN THE CHANNELS OF A HETEROGENEOUS NUCLEAR REACTOR. Etienne Picard (to Commissariat à l'Energie Atomique). U. S. Patent 3,109,929. Nov. 5, 1963. Priority date Feb. 17, 1959, France.

A device is designed for the automatic detection of can leaks in a multiplicity of coolant channels in a heterogeneous reactor. The device comprises a single detecting instrument, a plurality of coolant-conveying paths, switch means in the paths for connecting the instrument either simultaneously with all the channels in any subgroup or simultaneously with all the channels less one in any subgroup, control means for triggering an alarm signal, and means for operating the switch in one of several ways according to predetermined control programs. (D.L.C.)

3087 NUCLEAR REACTORS. Alan R. Kirkpatrick (to C. A. Parsons & Co., Ltd.). U. S. Patent 3,110,654. Nov. 12, 1963. Priority date Jan. 22, 1957, Great Britain.

A reactor is designed with a duct arrangement for the control rods and charge tubes. Separate ducts are provided for the control rods and charge tubes and are disposed so that the movable parts of the charge tubes can move a maximum distance of $\sqrt{10}$ × the pitch of the channels. Thus, each charge tube is capable of charging 37 channels, 12 of which are shared with adjacent tubes, and the ratio of control rod channels to fuel channels is 1:31. The resulting standpipe arrangement has a pitch of 4 × the channel pitch, and ample room is provided for reinforcement of the concrete shield. (D.L.C.)

3088 APPARATUS FOR INDIVIDUALLY ADJUSTING THE REGULATION OF THE COOLING FLUID FLOW IN THE CHANNELS OF A NUCLEAR REACTOR. Roger

Martin (to Commissariat à l'Énergie Atomique). U. S. Patent 3,110,655. Nov. 12, 1963. Priority date Jan. 20, 1958, France.

An apparatus and a method are described which permit the rapid adjustment of the coolant flow in any channel in a reactor. The flow is regulated by devices which are held in place by fingers engaging recesses in the channels. When the flow in one channel is to be changed, a hollow collecting tube is aligned with the bottom of the channel, and the regulating device is replaced. The fuel cartridges are not removed, and the power is reduced by only say 50% during the replacement. (D.L.C.)

3089 DEVICE FOR MEASURING THE TEMPERATURE INSIDE A NUCLEAR REACTOR. Pierre Albert Rault (to Compagnie Industrielle des Telephones). U. S. Patent 3,110,657. Nov. 12, 1963. Priority date Mar. 13, 1959, France.

A device is designed for measuring the temperature of cartridge sheaths in a reactor. The device comprises fixed conductive rings flush with the internal surface of the reactor channels and connected to an indicator device, and cartridges containing a thermocouple in contact with the sheath. The thermocouple is connected with external brushes which are arranged to come into contact with the fixed rings when the cartridges are put into place in the channels. (D.L.C.)

3090 DETECTION OF FISSION PRODUCTS IN A WATER COOLED REACTOR BY PRECIPITATING DAUGHTER PRODUCTS ON A LIQUID COVERED ELECTRODE. Murray Vincent Wilson (to Plessey Co., Ltd.). U. S. Patent 3,110,803. Nov. 12, 1963. Priority date June 19, 1959, Great Britain.

An apparatus is designed for detecting fission products in a first fluid carrier medium, particularly the coolant from a water-cooled reactor. The apparatus comprises two parallel, spaced porous plates, means for feeding the first fluid through one of the porous plates to produce a liquid film for the evaporation of fission product gases, means for feeding a second fluid through the other porous plate, and means for electrostatically precipitating the daughter products onto the second fluid. The second fluid is then passed to a detector for measuring the precipitated activity. (D.L.C.)

Crititicality Studies

3091 (ACNP-63032) SHAPED BURNABLE POISON DEVELOPMENT PROGRAM UNDER THE EURATOM PROGRAM. Quarterly Progress Report, July 1, 1963–September 30, 1963. (Allis-Chalmers Mfg. Co. Atomic Energy Div., Milwaukee). Oct. 10, 1963. Work Performed under United States–Euratom Joint Research and Development Program. Contract AT(11-1)-1229. 58p. (EURAEC-872)

The number and size of Gd_2O_3 poison cylinders were computed for a large boiling water reactor with H_2O-to-UO_2 ratio of 2.6, a U^{235} enrichment of 3.3 wt %, and Zr clad. The excess reactivity of the poisoned core was computed for the cold-clean, hot-clean non-voided, and hot full-power condition as a function of Mwd/t. For comparison, these calculations were repeated for B_4C as the burnable poison element for the same reactor. The use of Gd rather than B^{10} as the burnable poison reduces the moderator and void defect and provides a better match to the poison demand curve. For reactors in the lifetime range of 10,000 Mwd/t, the use of Gd results in a smaller poison residual. However, for lifetimes of approximately 20,000 Mwd/t, B^{10} and Gd are comparable. Methods were developed to account for the neutron interaction among clusters of Gd_2O_3 poison cylinders. Gadolinia cylinders in Al_2O_3 rods were formed and sintered to 3100°F. A reaction between Gd_2O_3 and Al_2O_3 begins at 2650°F. At 3000°F the reaction is complete with the integrity of the cylinders destroyed. The compound $GdAlO_3$ is formed. Gadolinia cylinders in UO_2 rods were formed and sintered to 3100°F. A reaction between Gd_2O_3 and UO_2 begins at 2850°F. At 3100°F the reaction is complete with the Gd_2O_3 diffused out of its original site and dispersed throughout the UO_2 matrix. Investigations were begun of the reaction between UO_2 and Gd_2O_3 mixed with other oxides such as Al_2O_3 in the form of the compound $GdAlO_3$. Twenty capsules were loaded with homogeneous mixtures of Al_2O_3, B_2O_3, and Gd_2O_3. Initial danger coefficient measurements were performed on the samples in the University of Wisconsin Reactor. (auth)

3092 (AE-123) THE NEUTRON SPECTRUM IN A URANIUM TUBE. E. Johansson, E. Jonsson, M. Lindberg, and J. Mednis (Aktiebolaget Atomenergi, Stockholm). Oct. 1963. 48p.

A lattice cell with a tube of natural uranium surrounded by heavy water was placed in the central, vertical channel of the reactor. The neutron spectrum from a lead scatterer in the uranium tube–outer diameter 49.2 mm, inner diameter 28.3 mm–was measured with a fast chopper in the energy region 0.01 to 100 ev. Subsidiary measurements indicated that the spectrum in the beam from the lead piece corresponds to the spectrum of the angular flux integrated over all angles. The thermal part of the spectrum was found to deviate significantly from a Maxwellian. However, the deviation is not very large, and a Maxwellian would give at least a rough idea of the hardness of the spectrum. The temperature of this Maxwellian was estimated as 90 to 100°C above the moderator temperature (33°C). In the joining region the rise of the spectrum toward the thermal part is slower than for the cell boundary spectrum, measured previously. In the epithermal region the limited resolution of the chopper affected the measurements at the energies of the uranium resonances. However, the shape of the spectrum on the flanks of the first resonance in U^{238} (6.68 ev) was obtained accurately. In the theoretical treatment the THERMOS code with a free gas scattering model has been used. The energy region was 3.06 to 0.00025 ev. The agreement with the measurements is good for the thermal part–possibly the theoretical spectrum is a little softer than the experimental one. In the joining region the results from THERMOS are comparatively high, probably due to the scattering model used. (auth)

3093 (APED-4236) CONTROL AUGMENTATION CRITICAL EXPERIMENTS. T. R. Jaworowski, P. G. Aline, and H. D. Kosanke (General Electric Co. Vallecitos Atomic Lab., San Jose, Calif.). July 15, 1963. Contract [AT(04-3)-189]. 74p.

Critical experiments are reported for clumped heterogeneous light water moderated lattices using 3 wt % enriched UO_2 fuel clad with stainless steel. Reactivity worth utilizing water height and pulsed neutron techniques, temperature and void coefficients, flux and power distributions, and spectral indicator activations were measured for a wide range of configurations. These configurations were typical of boiling water reactor lattices and included assemblies with black and gray absorbing slabs and control rod cruciforms. Differential reactivity and spectrum effects were investigated for various slab, cruciform and

void tube perturbations in these experiments. The resonance spectral indicator method was used in particular to study the spatial variation of the neutron spectrum and density in a typical boiling water reactor lattice. The observed spatial neutron spectrum variations show that this is a very useful technique. (auth)

3094 (CONF-187-12) REACTIVITY WORTH OF TRANSVERSE GAPS. S. Weinstein and F. Feiner (Knolls Atomic Power Lab., Schenectady, N. Y.). Nov. 1963. Contract W-31-109-eng-52. 6p.

From American Nuclear Society Meeting, New York, Nov. 1963.

Fuel blocks of compacted ZrO_2 and UO_2 powder in paraffin were added axially to two unreflected assemblies (20 × 16 in. and 20 × 24 in. cross sections). The separation of the assembly halves when criticality occurred was determined, and the reactivity worth at a given critical gap size was obtained by bringing the halves slightly closer together and observing the reactor period. The core with the larger cross section had a maximum gap twice that of the smaller core. Diffusion theory treatment agreed with the data reasonably well for small gap thickness. (D.C.W.)

3095 (EUR-470.e) THEORETICAL ANALYSIS OF SOME PROBLEMS WHICH ARE DUE TO THE PRESENCE OF PLUTONIUM IN HETEROGENEOUS THERMAL REACTORS. E. Diana (European Atomic Energy Community. Nuclear Research Center, Ispra, Italy). 1963. 18p.

Oscillation experiments with Pu-containing fuel elements are planned. To study the inference that can be drawn from such integral measurements for the calculation of the reactivity of irradiated lattices the influence of the plutonium on the thermal spectrum in the fuel as well as in the moderator was investigated. Also, the effects of a non-uniform spatial distribution of the plutonium in the fuel was studied. The values of the heterogeneous parameters for such a fuel were estimated. (auth)

3096 (GNEC-282) STATE OF THE ART PHYSICS OF NUCLEAR SUPERHEAT REACTORS. Michael F. Valerino and Robert S. Harding (General Nuclear Engineering Corp., Dunedin, Fla.). June 17, 1963. Contract AT (11-1)-795. 564p.

An evaluation was made of the state of the art of reactor physics calculations for nuclear superheat reactors at the beginning of life. The evaluation included compilation of the available critical experiment data and application of the calculational techniques, developed for superheat lattices, to selected data covering the appropriate range of variables and reactor lattice conditions. (M.C.G.)

3097 (HW-SA-2934) MEASUREMENT OF THE ANGULAR DISTRIBUTION OF THERMAL NEUTRONS AT THE SURFACES OF CADMIUM RODS. D. E. Wood (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). [Feb. 28, 1963]. Contract AT(45-1)-1350. 30p.

The angular distribution of thermal neutrons was measured at the surfaces of cadmium bars in the graphite core of the Physical Constants Test Reactor. The distribution was obtained by activating dysprosium detectors placed at the bottom of small holes in the cadmium. Theoretical calculations of the distributions were made with the optical path method and with two versions of the S_n method: HAPO Program S and the Los Alamos DSN code. All methods agreed to within the three percent standard deviation of the measurements. (auth)

3098 (IDO-16752) TRANSIENT TESTS OF THE SPERT I LOW-ENRICHMENT UO_2 CORE: DATA SUMMARY REPORT. R. Scott, Jr., A. A. Wasserman, and R. C. Schmitt (Phillips Petroleum Co. Atomic Energy Div., Idaho Falls, Idaho). Sept. 3, 1963. Contract AT (10-1)-205. 93p.

This report supplements IDO-16751, which describes step-induced transient tests performed in the uranium oxide core in the Spert I reactor facility. It (a) presents a complete set of graphs and tables of the data taken in these tests; (b) describes the methods used in processing the data; and (c) provides more complete information on the special instrumentation used for the excursion-test measurements of reactor power, temperature, and pressure. (auth)

3099 (IDO-16925(p.23-30)) THE CRITICAL ASSEMBLY FUEL ELEMENT EXCHANGE. Saul Strauch (New York Operations Office, AEC).

The Critical Assembly Fuel Element Exchange (CAFEE) Program was established to obtain the maximum utilization of AEC-owned critical assembly fuels. A storage facility was established at CANEL for fuels that have no immediate use, but where future AEC need is seen. CAFEE provided national laboratories and AEC contractors in universities and in industry with fabricated critical assembly fuel for their programs charging only shipping costs. CAFEE also accepted donations of critical assembly fuel from licensees with the waiver of the licensees reprocessing responsibility. (auth)

3100 (ORNL-TM-725) SPATIAL WEIGHTING FUNCTIONS FOR CALCULATIONS OF REACTIVITY. C. A. Preskitt (Oak Ridge National Lab., Tenn.). Nov. 1, 1963. Contract [W-7405-eng-26]. 6p.

The reactivity resulting from nonuniform changes in core properties is discussed. It is shown that a satisfactory weighting function for axially nonuniform changes in the Experimental Gas Cooled Reactor is simply the square of the power density. (auth)

3101 (STL-6306) KINETIC STUDIES OF HETEROGENEOUS WATER REACTORS. Quarterly Progress Report, for Period Ending June 30, 1963. R. W. Wright and S. M. Zivi (Space Technology Labs., Inc., Redondo Beach, Calif.). July 15, 1963. Contract AT(04-3)-372. 34p.

An investigation is made to determine whether the multithousand psi pressure pulses that occurred in the BORAX-I and SPERT-I destructive power excursions were generated by thermal mechanisms in the geometries of the unmolten reactor cores. An evaluation is made of prompt and delayed pressure pulses. The effects of vapor blanketing are also investigated. The differences between the BORAX-I and SPERT-I destructive transients, particularly with regard to pressure behavior, prompted calculations on temperature histories and extent of fuel melting in the two experiments. Results are presented on the hydrodynamic stability of the boiling reactors. (N.W.R.)

3102 (UCRL-7023) ABYSS—A NARROW RESONANCE, EPITHERMAL NEUTRON CAPTURE PROBABILITY CODE FOR INFINITE PLANE LATTICES. G. M. Benson and B. K. Crowley (California. Univ., Livermore. Lawrence Radiation Lab.). June 30, 1962. Contract W-7405-eng-48. 51p.

The ABYSS program calculates the neutron absorption probabilities per absorber resonance for absorber foils lying in moderator slots. The theory and equations are presented, and the operating instructions and input are discussed. A sample problem is also included. (D.C.W.)

3103 A MEAN SQUARE STABILITY CRITERION FOR NUCLEAR REACTORS. Abdi Dalfes (Technical Univ., Istanbul). Istanbul Tek. Univ. Bul., 16: 7-11(1963).

The macrostochastic approach is used to derive a sufficient mean square stability criterion for a nuclear reactor. This criterion depends only on the characteristics of the feedback model of the reactor. (auth)

3104 CRITICAL SIZE AND FLUX DISTRIBUTION MEASUREMENTS IN HIGHLY ENRICHED, LIGHT WATER MODERATED LATTICES. I. Johnstone, W. H. Taylor, and S. K. Wallace (Atomic Energy Establishment, Winfrith, Eng.). J. Brit. Nucl. Energy Soc., 2: 379-90(Oct. 1963).

The experimental determinations of critical size and flux distributions in critical and sub-critical assemblies using fuel packs consisting of Al–U and stainless steel plates are described. The results show that few-group models are adequate for calculating the critical size of highly absorbing light water moderated lattices and that material buckling and thermal fine structure measurements can be made in light water moderated assemblies as small as 12 in. square and 24 in. high. (D.C.W.)

3105 DIRECT MEASUREMENT OF REACTIVITY IN A SUBCRITICAL REACTOR USING A REPEATED PULSED NEUTRON SOURCE. J. Lewins. Nucl. Energy, 316-18 (Nov. 1963).

The kinetics of a reactor with a pulsed neutron source are considered, first for a single pulse and then for a steady repetition of pulses. It is shown that the ratio of the integrated density associated with the prompt behavior to that associated with the delayed behavior is the shutdown reactivity in dollars. An experiment to determine the reactivity of a sub-critical system directly, without the usual associated experiment or calculation is presented. The counts associated with the prompt pulse and the delayed neutron steady background in the cycle of a repetitively pulsed reactor are measured. (auth)

3106 SIGNALS FOR TESTING NONLINEAR SYSTEMS. Elias P. Gyftopoulos and Richard J. Hooper (Massachusetts Inst. of Tech., Cambridge). Trans. Am. Nucl. Soc., 6: 211-12(Nov. 1963).

3107 LIMITATIONS OF THE INHOUR FORMULA. A. F. Henry (Westinghouse Electric Corp., Pittsburgh). Trans. Am. Nucl. Soc., 6: 212-13(Nov. 1963).

3108 THE ROLE OF THE REACTOR DISPERSION FUNCTION IN THE NOISE FIELD OF A REACTOR. M. N. Moore (Univ. of Florida, Gainesville). Trans. Am. Nucl. Soc., 6: 213-14(Nov. 1963).

3109 NEUTRON FLUCTUATIONS IN REACTORS OF FINITE SIZE. D. R. Harris (Westinghouse Electric Corp., Pittsburgh). Trans. Am. Nucl. Soc., 6: 214-15(Nov. 1963).

3110 SPACE-DEPENDENT TRANSFER FUNCTIONS. William E. Loewe (Illinois Inst. of Tech., Chicago). Trans. Am. Nucl. Soc., 6: 215-16(Nov. 1963).

3111 OSCILLATIONS INDUCED BY TWO REACTIVITY FEEDBACK COEFFICIENTS. Louis M. Shotkin (Brookhaven National Lab., Upton, N. Y.). Trans. Am. Nucl. Soc., 6: 216(Nov. 1963).

3112 CRITICAL EXPERIMENTS AND CALCULATIONS WITH ANNULAR CYLINDERS OF U(93.2) METAL. J. T. Mihalczo (Oak Ridge National Lab., Tenn.). Trans. Am. Nucl. Soc., 6: 217-18(Nov. 1963).

3113 REACTIVITY WORTH OF TRANSVERSE GAPS. S. Weinstein and F. Feiner (Knolls Atomic Power Lab., Schenectady, N. Y.). Trans. Am. Nucl. Soc., 6: 221(Nov. 1963).

3114 EFFECTS OF CONTROL BLADES IN LATTICES MODERATED BY D_2O/H_2O MIXTURES. R. H. Clark, E. J. DeRoche, G. T. Fairburn, J. W. Hallam, and T. C. Engelder (Babcock and Wilcox Co., Lynchburg, Va.). Trans. Am. Nucl. Soc., 6: 221-2(Nov. 1963).

3115 A SIMPLIFIED FORMULATION OF SPACE-ENERGY CELL THEORY. K. B. Cady and C. R. MacVean (Cornell Univ., Ithaca, N. Y.). Trans. Am. Nucl. Soc., 6: 234-5(Nov. 1963).

3116 REACTIVITY EFFECT OF HYDROGENOUS COOLANTS IN D_2O-MODERATED LATTICES. W. L. Brooks, M. Fleishman, G. G. Foster, C. W. Monroe, and R. D. Schamberger (United Nuclear Corp., White Plains, N. Y.). Trans. Am. Nucl. Soc., 6: 244(Nov. 1963).

3117 EXPERIMENTAL BUCKLINGS AND MIGRATION AREAS IN D_2O-MODERATED LATTICES OF NATURAL-URANIUM METAL TUBES. A. E. Dunklee and W. E. Graves (E. I. du Pont de Nemours & Co., Aiken, S. C.). Trans. Am. Nucl. Soc., 6: 244-5(Nov. 1963).

3118 MEASUREMENTS OF BUCKLINGS AND DIFFUSION-COEFFICIENT CHANGES IN D_2O-MODERATED LATTICES OF TUBULAR UO_2 ASSEMBLIES. H. R. Fike and W. E. Graves (E. I. du Pont de Nemours & Co., Aiken, S. C.). Trans. Am. Nucl. Soc., 6: 245-6(Nov. 1963).

3119 BUCKLINGS, DISADVANTAGE FACTORS AND δ^{28} MEASUREMENTS IN SOME UNDERMODERATED SLIGHTLY ENRICHED CORES. Q. L. Baird and A. R. Boynton (Argonne National Lab., Ill.). Trans. Am. Nucl. Soc., 6: 248(Nov. 1963).

3120 EFFECTS OF FLUX CHANGES UPON REACTIVITY LIFETIME AND BURNUP. J. R. L. de Ladonchamps and T. H. Pigford (Univ. of California, Berkeley). Trans. Am. Nucl. Soc., 6: 270-1(Nov. 1963).

3121 A VARIATIONAL PRINCIPLE FOR HETEROGENOUS RESONANCE CAPTURE. Paul F. Gast (General Electric Co., Hanford, Wash.). Trans. Am. Nucl. Soc., 6: 271-2(Nov. 1963).

3122 CRITICAL CONDITIONS IN ASYMPTOTIC REACTOR THEORY. Joel H. Ferziger (Stanford Univ., Calif.) and P. F. Zweifel. Trans. Am. Nucl. Soc., 6: 274(Nov. 1963).

3123 RESPONSE MATRIX METHOD FOR CRITICALITY CALCULATIONS OF TWO-DIMENSIONAL REACTORS. Akinao Shimizu and Tadakatsu Aoki (NAIG Nuclear Research Lab., Kawasaki, Japan). Trans. Am. Nucl. Soc., 6: 281-2(Nov. 1963).

3124 MEASUREMENTS OF SUBCRITICAL REACTIVITY USING A PULSED-NEUTRON SOURCE. J. R. Brown, J. C. Young, J. R. Beyster, D. H. Houston, and W. R. Mowry (General Atomic Div., General Dynamics Corp., San Diego, Calif.). Trans. Am. Nucl. Soc., 6: 284-5(Nov. 1963).

3125 A PULSED-SOURCE METHOD FOR DETERMINING THE NEUTRON-ABSORPTION CHARACTERISTICS OF HETEROGENEOUS REACTOR CELLS. Boyd W. Johnson and Arthur W. Waltner (North Carolina State Coll., Raleigh, N. C.). Trans. Am. Nucl. Soc., 6: 285-6(Nov. 1963).

3126 TRANSFER-FUNCTIONS OF A LINEARIZED MULTI-REGION REACTOR. Thomas J. Higgins (Univ. of Wisconsin, Madison). Chicago, Instrument Society of America, 1963, Preprint 25.4.63, 24p, $1.00. (CONF-147-11)

From Instrument Society of America Conference, Chicago, Sept. 1963.

The development of the transfer functions for a linearized multi-region reactor is studied, and an illustration is made of application of the corresponding theory by a numerical illustrative example. (auth)

3127 NUCLEAR REACTORS. Leslie Reginald Blake (to United Kingdom Atomic Energy Authority). U. S. Patent 3,109,802. Nov. 5, 1963. Priority date Jan. 12, 1959, Great Britain.

A core for a fast reactor is designed with means for loading and unloading of fuel elements. The core is constituted by a plurality of adjacent slab-like frame members with guides for the fuel element blocks. A loading station and an unloading station are provided with means for moving the fuel elements into register with the stations. The core can also be applied to a materials testing reactor. (D.L.C.)

Design and Feasibility

3128 (NAA-SR-Memo-8949) THE SODIUM REACTOR THERMAL DESIGN (SORTD) PROGRAM. G. C. Burry and C. G. Johnson (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). Sept. 5, 1963. 34p.

The SORTD program performs a complete heat transfer analysis and core sizing of calandria-type sodium reactor systems. By proper adjustment of two input variables, the code can be used for other sodium-type systems. The code is particularly useful for parameter studies and optimization techniques because of the simplicity of input and the use of the FORTRAN DECIMAL READ routine. In addition to a complete list of core parameters printed as output, the code calculates axial temperature profiles in the coolant, clad and fuel based upon a cosine axial power distribution. Complete instructions for using the code, a sample input and output, the FORTRAN listing, and the equations are included. (auth)

3129 CREATION OF A FLAT FIELD OF ENERGY RELEASE IN A REACTOR WITH UNIFORM CHARGE. V. N. Golubenkov. Inzh. Fiz. Zh., Akad. Nauk Belorussk. SSR, 6: No. 9, 52-6(Sept. 1963). (In Russian)

A reactor with only thermal fission is studied on the basis of the two-group theory. Such an approach makes it possible to obtain a distribution law of a moderator and absorbent in explicit form. The distribution of the moderator with a constant distribution of the absorbent for unidimensional reactors is given. For a constant distribution of the moderator for a flat, cylindrical, and spherical geometry the distributions of the absorbent involving a constant flow of thermal neutrons are given. (auth)

3130 FAST REACTOR CONSIDERATIONS AND PROBLEMS. L. J. Koch (Argonne National Lab., Ill.). Trans. Am. Nucl. Soc., 6: 310(Nov. 1963).

3131 ANALYSIS OF REACTOR-GRID DEFORMATION UNDER MECHANICAL AND THERMAL LOADINGS. M. M. Chen and A. Smaardyk (Argonne National Lab., Ill.). Trans. Am. Nucl. Soc., 6: 327-8(Nov. 1963).

3132 EFFECT OF EDDY DIFFUSION ON TEMPERATURES IN A PARTICULATE-FUELED, FIXED-BED REACTOR. James J. Barker and Robert F. Benenati (Brookhaven National Lab., Upton, N. Y.). Trans. Am. Nucl. Soc., 6: 336-7(Nov. 1963).

3133 NEUTRON TRANSPORT THROUGH ESADA-HTGR GAS-COOLANT DUCTS. B. A. Engholm (General Atomic Div., General Dynamics Corp., San Diego, Calif.). Trans. Am. Nucl. Soc., 6: 427(Nov. 1963).

Fuels

Refer also to abstract 1862.

3134 (GEAP-4094) FUEL CYCLE PROGRAM. A BOILING WATER REACTOR RESEARCH AND DEVELOPMENT PROGRAM. Ninth Quarterly Progress Report, July–September 1962. C. L. Howard, comp. (General Electric Co. Atomic Power Equipment Dept., San Jose, Calif.). Oct. 25, 1962. Contract AT(04-3)-189. 114p.

Studies are reported on the dynamic stability of boiling-water reactors (BWR's); fuel burnup and isotopic changes upon irradiation in BWR's; development of UO_2-based fuels and fuel elements for BWR's; Zircaloy and stainless steel performance as cladding for these fuels; and heat transfer and fluid dynamics in BWR's. (T.F.H.)

3135 (IDO-16925(p.13-21)) DETERMINATION OF BURNUP OF REACTOR FUEL. B. F. Rider and H. W. Donovan (General Electric Co. Atomic Power Equipment Dept., San Jose, Calif.).

Charges incurred for the burnup of fissionable isotopes represent a significant portion of the total fuel cycle cost. Therefore, the methods employed in the determination of this burnup, and the cause and magnitude of the relative uncertainties inherent in the measurement, are important. The advantages and disadvantages of the radiochemical and mass spectrometric methods are discussed. A description of some work being undertaken to improve the accuracy of burnup determinations is presented. (auth)

3136 (TID-7665) FUEL MANAGEMENT SYMPOSIUM, HELD AT NEW YORK OPERATIONS OFFICE, NEW YORK, N. Y., SEPTEMBER 27, 1962. (Jackson and Moreland, Inc., Boston). 146p.

Eight papers presented at the Fuel Management Symposium are given. Separate abstracts were prepared for each paper. (M.C.G.)

For abstracts of individual papers see: 3137, 3138, 3191, 3192, 3193, 3194, 3195, and 3196.

3137 (TID-7665(p.57-81)) SOME RECENT FUEL MANAGEMENT STUDIES AT ORNL. Paul R. Kasten (Oak Ridge National Lab., Tenn.).

Some machine programs being developed at ORNL that are useful in fuel-management evaluations are described. These programs are MERC and EQUIPOISE-BURNOUT. Specific fuel management studies for some gas-cooled graphite-moderated reactors are discussed. Results are presented for three fuel-management schemes. (M.C.G.)

3138 (TID-7665(p.103-26)) PROPERTIES OF PuO_2 FUEL THAT AFFECT FUEL MANAGEMENT IN THERMAL REACTORS. Karl Puechl (Nuclear Materials and Equipment Corp., Apollo, Penna.).

Calculations were made of the properties of PuO_2 fuel that affect fuel management in thermal reactors to guide a fuel element–fuel materials development program. The behavior of near-thermal reactors that are fueled with reactor grade plutonium is described. The desirability of reshuffling fuel during reactor operation is considered. (M.C.G.)

3139 (WAPD-T-1499) INVESTIGATIONS OF BURNUP DETERMINATIONS ON HIGHLY IRRADIATED FUELS BY MASS SPECTROMETRIC METHODS. H. D. Cook, C. J. Rettger, and W. J. Sewalk (Westinghouse Electric Corp. Bettis Atomic Power Lab., Pittsburgh). May 1962. Contract AT(11-1)-Gen-14. 17p. (CONF-312-1)

From 3rd Conference on Nuclear Reactor Chemistry, 6th Conference on Analytical Chemistry in Nuclear Reactor Technology, Gatlinburg, Tenn., Oct. 1962.

It is noted that fuel burnup analyses, performed on irradiated test specimens and expended reactor fuel elements, aid in development of new PWR fuel materials for long life central station nuclear power reactors. An analysis of selected PWR fuel blanket rods is described. Results indicate that several stable fission products can

provide reliable total fission analyses of highly irradiated PWR fuel blanket rods. It is concluded that problems encountered in other procedures are eliminated or minimized by mass spectrometric techniques. Accuracy is also improved over other methods. (J.R.D.)

3140 (WAPD-T-1615) USE OF RADIOCHEMISTRY AND MASS SPECTROMETRY FOR FUEL DEPLETION STUDIES. J. E. Hudgens (Westinghouse Electric Corp. Bettis Atomic Power Lab., Pittsburgh). Aug. 1963. Contract AT(11-1)-Gen-14. 11p. (CONF-313-1)

From 2nd National Meeting of the Society for Applied Spectroscopy, San Diego, Calif., Oct. 1963.

Development of radiochemical and mass spectroscopic techniques applicable to fuel technology is discussed. Particular emphasis is placed on applications in the Shippingport Pressurized Water Reactor. It is noted that mass spectrometry and gamma spectrometry were used to establish the integrated exposure or burnup for fuels exposed in PWR. Surface deposits and internal impurities in fuels were also determined by mass spectrometry. (J.R.D.)

3141 (ZFK-WF-20) VERTRÄGLICHKEIT VON SPALTSTOFFEN MIT KONSTRUKTIONSWERKSTOFFEN. TEIL II. VERTRÄGLICHKEIT VON KERAMISCHEN SPALTSTOFFEN MIT HÜLLENWERKSTOFFEN UND METALLISCHEN MATRIXELEMENTEN. (Compatibility of Fuels with Construction Materials. Part II. Compatibility of Ceramic Fuels with Cladding Materials and Metallic Matrix Elements). Heinz-Eberhard Roellig (Germany. Zentralinstitut für Kernphysik, Dresden). June 1962. 43p.

The same compatibility requirements were required basically for ceramic fuels as for metallic fuels. The ceramic materials were introduced either as compacts or in dispersions in a metallic matrix in the fuel elements of heterogeneous reactors. When diffusion reactions with the cladding material play a significant role as in metallic fuels, chemical reactions, e.g., reduction of the oxidic fuels by the metal of the sheath or the matrix, also occur. Both diffusion and chemical reactions can take place between the ceramic fuel and the sheath, the matrix element, or both. Secondary reactions can arise between the cladding material and the reaction products formed in the dispersion. The ratios are somewhat complicated, but ceramic materials are, in general, slower to react than metallic materials, even at higher temperatures. Reactions of ceramic sintered bodies with a metallic sheath are, at the operating temperatures of thermal reactors, scarcely of decisive significance, but they can be important in fast high-temperature reactors. Reactions between matrix elements and the finely dispersed ceramic particles are to be suspected at relatively low temperatures because of the very large contact surface and the thereby increased activity. Other conditions are exhibited since under radiation effects localized very high temperatures occur at the interior of the fuel element, whereas the temperature on the sheath (with suitable cooling from the outside) are relatively low. (tr-auth)

3142 SPATIAL VARIATIONS OF THE ISOTOPIC CONCENTRATIONS IN A FUEL ROD. C. Bruschi (Laboratori CISE, Segrate, Italy). Energia Nucl. (Milan), 10: 469-80(Sept. 1963).

The thermal neutron flux in a heterogeneous reactor is strongly depressed in the fuel element. Therefore the depletion of U^{235} and the build-up of Pu^{239} are much faster in the outer region than in the center of the fuel element. A method is described that takes into account this non-uniform isotopic distribution, as well as the variations of the neutron spectrum, and therefore of the cross sections, with the radius of the fuel element. (auth)

3143 EFFECTIVE CONCENTRATIONS IN LUMPED FUEL FOR REACTIVITY LIFETIME ANALYSIS. J. R. L. de Ladonchamps and T. H. Pigford (Univ. of California, Berkeley). Trans. Am. Nucl. Soc., 6: 269-70(Nov. 1963).

3144 TREATMENT OF LEAKAGE AND SPATIAL EFFECTS IN ZERO-DIMENSIONAL BURN-UP CALCULATIONS. K. R. Van Howe (General Atomic Div., General Dynamics Corp., San Diego, Calif.). Trans. Am. Nucl. Soc., 6: 279-80(Nov. 1963).

3145 PERFORMANCE CRITERIA AND STATUS OF SOME FAST REACTOR FUELS. Edwin Zebroski (General Electric Co., San Jose, Calif.). Trans. Am. Nucl. Soc., 6: 312(Nov. 1963).

3146 SOME ECONOMIC CONSEQUENCES OF PLUTONIUM INTERCHANGE IN THERMAL REACTORS AS AFFECTED BY ISOTOPIC COMPOSITION, MODERATOR TYPE, FUELING MODE, AND CLAD MATERIAL. R. L. Watts (General Electric Co., Richland, Wash.). Trans. Am. Nucl. Soc., 6: 322-3(Nov. 1963).

3147 EXPLOITING PLUTONIUM-240 BY REDUCING URANIUM-238 CONCENTRATIONS. Marvin M. Hendrickson (General Electric Co., Richland, Wash.). Trans. Am. Nucl. Soc., 6: 323-4(Nov. 1963).

3148 SOME OBSERVATIONS ON FISSILE-FUEL CONSERVATION IN THERMAL REACTORS. Melvin F. Kanninen (General Electric Co., Richland, Wash.). Trans. Am. Nucl. Soc., 6: 324-5(Nov. 1963).

3149 IN-PILE EFFECTIVE THERMAL CONDUCTIVITY OF OXIDE FUEL ELEMENTS TO HIGH FISSION DEPLETIONS. R. C. Daniel and I. Cohen (Westinghouse Electric Corp., Pittsburgh). Trans. Am. Nucl. Soc., 6: 332-3(Nov. 1963).

3150 CONSEQUENCES OF CLADDING RUPTURE WITH MOLTEN UO_2 FUELS. B. Weidenbaum, M. F. Lyons, D. H. Coplin, R. C. Nelson, and T. J. Pashos (General Electric Co., San Jose, Calif.). Trans. Am. Nucl. Soc., 6: 346-7(Nov. 1963).

3151 CORRELATION OF UO_2 FUEL-ELEMENT MELTING DATA. Truman D. Anderson (Oak Ridge National Lab., Tenn.). Trans. Am. Nucl. Soc., 6: 347-8(Nov. 1963).

3152 OPERATION OF COMPACTED-POWDER UO_2 FUEL RODS WITH CENTRAL MELTING. M. F. Lyons, R. C. Nelson, T. J. Pashos, and B. Weidenbaum (General Electric Co., San Jose, Calif.). Trans. Am. Nucl. Soc., 6: 351-2(Nov. 1963).

3153 THE IMPORTANCE OF COATED-PARTICLE FUEL TO CIVILIAN POWER REACTOR DEVELOPMENT. R. E. Pahler (Atomic Energy Commission, Washington, D. C.). Trans. Am. Nucl. Soc., 6: 377(Nov. 1963).

3154 PROPERTIES OF CERAMIC-COATED NUCLEAR FUEL PARTICLES. J. M. Blocher, Jr., M. F. Browning, W. J. Wilson, V. M. Secrest, A. C. Secrest, R. B. Landrigan, and J. H. Oxley (Battelle Memorial Inst., Columbus, Ohio). Trans. Am. Nucl. Soc., 6: 377-8(Nov. 1963).

3155 PREPARATION AND TESTING OF COATED-PARTICLES FUELS. R. E. Latta and C. C. Browne (General Electric Co., Cincinnati). Trans. Am. Nucl. Soc., 6: 379(Nov. 1963).

3156 RADIATION AND CREEP ANALYSIS FOR STRESS DISTRIBUTION IN ANNULAR FUEL ELEMENTS.

Benjamin M. Ma and Glenn Murphy (Ames Lab., Ames, Iowa). Trans. Am. Nucl. Soc., 6: 390(Nov. 1963).

3157 DIMENSIONAL INSPECTION OF RADIOACTIVE FUEL ELEMENTS. J. A. Scanlan and H. Portig (Univ. of Texas, Austin). Trans. Am. Nucl. Soc., 6: Suppl., 3(Oct. 1963).

3158 DEVICES FOR SECURING FUEL ELEMENTS IN TUBULAR METAL CASINGS FOR USE IN NUCLEAR REACTORS. Bertrand Roger Georges Guibert (to Commissariat à l'Énergie Atomique). U. S. Patent 3,110,658. Nov. 12, 1963. Priority date Nov. 18, 1959, France.

A device is designed for securing an assembly of fuel elements in a tubular metal casing without screws, bolts, or rivets for use in heavy water reactors. The device comprises rings which are adapted to bear against the inner wall of the casing and mounted at the ends of the fuel elements through locking means arranged in such a manner that, when the rings are engaged, centered, and fixed in the casing, unlocking is impossible. (D.L.C.)

3159 TUBULAR FUEL ELEMENTS AND FABRICATING TECHNIQUES THEREFOR. William A. Maxwell (to Martin-Marietta Corp.). U. S. Patent 3,109,797. Nov. 5, 1963. Filed Oct. 1, 1957.

A tubular fuel element is described which comprises a plurality of fuel cermet collars enclosed between inner and outer tubes. The fuel loading may be arranged to give the highest fuel concentration near the ends for better power distribution. The final end portions are inactive, acting to seal the element. Several methods are described for forming the fuel collars and for effecting metallurgical bonding between the collars and the inner and outer tubes. (D.L.C.)

Power and Power-Breeder Reactors

Refer also to abstract 3134.

3160 (ACNP-63018) CONTROL ROD DRIVE PROTOTYPE TEST REPORT. J. Patterson, E. Duewel, R. Kern, M. Jury, R. Grenda, A. McIlheran, and M. McDermott (Allis-Chalmers Mfg. Co. Atomic Energy Div., Milwaukee). Oct. 25, 1963. For Northern State Power Co., Minneapolis and Central Utilities Atomic Power Associates. Contract AT(11-1)-589. 57p.

An evaluation under simulated Pathfinder reactor operating conditions of a prototype Pathfinder control rod drive (described) indicated that the unit will perform satisfactorily under all Pathfinder operating conditions. Tests were performed on individual components of the drive and on the assembled drive. (D.C.W.)

3161 (ACNP-63539) ELK RIVER REACTOR—THERMAL AND HYDRAULIC PERFORMANCE. (Allis-Chalmers Mfg. Co. Atomic Energy Div., Milwaukee). Apr. 11, 1963. Contract AT(11-1)-589. 106p.

The Elk River Reactor (ERR) performance was re-evaluated in the light of EBWR operational experience, and it was found that steam carry under with recirculating water would be excessive. Air-water tests of several possible modifications suggested by ANL experience were made to select the best modifications and to provide a basis for evaluating ERR performance with carry under. A description and drawings of the modifications are given, as well as the test results. The re-evaluation of ERR performance based on the air-water tests of the selected modifications is summarized and described, and limitations to thermal performance and operational approach to full power are discussed. (auth)

3162 (AECL-1682) THE ENGINEERING DESIGN AND OPERATION OF NPD REACTOR. (Atomic Energy of Canada Ltd., Chalk River, Ont.). [nd]. 165p.

The design and operation of the Nuclear Power Demonstration Plant are described by six papers presented at the 1962 winter meeting of the American Nuclear Society in Washington, D. C. Five of the papers are abstracted separately in NSA; the other paper was abstracted in NSA previously. (N.W.R.)

For abstracts of individual papers see: 3163, 3164, 3165, 3166, and 3167.

3163 (AECL-1682(p.1-9)) NPD—GENERAL DESCRIPTION OF STATION. I. N. MacKay (Canadian General Electric Co., Ltd. Civilian Atomic Power Dept., Peterborough, Ont.).

A general description of the heavy water moderated and cooled, natural uranium oxide-fueled power reactor is presented. The characteristics of the 20-Mw(e) reactor are given. (N.W.R.)

3164 (AECL-1682(p.11-25)) REACTOR CONTROL OF THE NUCLEAR POWER DEMONSTRATION. W. S. Brown (Canadian General Electric Co., Ltd. Civilian Atomic Power Dept., Peterborough, Ont.).

In NPD, moderator level is regulated to act as the prime control of reactivity, with on-power refueling compensating for fuel burnup. Emergency shutdown dumps all the moderator from the reactor vessel into a dump tank. If a restart is required before the reactor poisons out, booster rods can be inserted, and, until the equilibrium fuel charge is reached, moderator temperature can also be reduced. The reactor power regulating system provides automatic startup and shutdown of the plant. Both the regulating and protective systems are triplicated, and independently operate sets of control and dump valves designed so that failure of one channel of control or protection does not affect normal plant operation or safety. (N.W.R.)

3165 (AECL-1682(p.27-51)) THE NPD ON-POWER FUELLING SYSTEM. W. M. Brown (Canadian General Electric Co., Ltd. Civilian Atomic Power Dept., Peterborough, Ont.).

The refueling system described is specifically designed to fulfill fuel shifting requirements in a hot pressurized heavy water environment and to suit the physical arrangement chosen for the reactor structure. The performance of the NPD on-power fueling system, based on off-reactor testing, initial loading of the reactor and limited refueling is satisfactory. Development, servicing, emergency handling, and operating experience are discussed. (N.W.R.)

3166 (AECL-1682(p.53-69)) FUEL MANUFACTURING DEVELOPMENT FOR THE NUCLEAR POWER DEMONSTRATION (NPD) REACTOR. J. G. Matthew (Canadian General Electric Co., Ltd. Civilian Atomic Power Dept., Peterborough, Ont.).

Fuel for the NPD Reactor is natural uranium dioxide sintered pellets ground to fit Zircaloy-2 tubular sheaths. After closure welding, the sealed tubes are assembled into bundles 19½-in. long and 3¼-in. dia., consisting of either seven 1-in. dia. or nineteen 0.6-in. dia. elements. Each completed fuel bundle weighs 36 lb. High-speed resistance welding is applied to element closures and bundle assembly in place of fusion welding. Development and performance requirements are discussed. (N.W.R.)

3167 (AECL-1682(p.71-102)) MANUFACTURING COMPONENTS FOR NPD. C. L. Willcox (Canadian General Electric Co., Ltd. Civilian Atomic Power Dept., Peterborough, Ont.).

The problems and experience associated with manufacturing some of the NPD components are discussed. Information is included on the fabrication of pressure tubes, stainless steel end fittings for Zircaloy-2 pressure tubes, fueling machine magazine housing, calandria, steam generator, pumps, heat exchangers, instrumentation and control systems, and shielding. (N.W.R.)

3168 (AP-Note-239) EFFECT OF AN INCONEL STEAM GENERATOR ON DEPOSITED ACTIVITY AND WATER TREATMENT OF THE PM-2A. Carl A. Bergmann (Alco Products, Inc., Schenectady, N. Y.). Mar. 25, 1960. Contract DA-30-347-eng-284. 33p.

An analysis was made of the effects of an Inconel steam generator on activity deposition in the PM-2A primary system. Equations were derived for determining amounts of activated corrosion products released from in-flux and out-of-flux surfaces. The results permit comparison of predicted activity from a 50% Inconel – 50% stainless steel system with activity from an all stainless steel system. A discussion of the methods of treatment of the primary and secondary waters in contact with an Inconel steam generator was given. (auth)

3169 (BAW-1274) SPECTRAL SHIFT CONTROL REACTOR BASIC PHYSICS PROGRAM. MEASUREMENT AND ANALYSIS OF PERTURBED LATTICES OF SLIGHTLY ENRICHED UO_2 MODERATED BY D_2O-H_2O MIXTURES. T. C. Engelder, R. H. Clark, E. J. DeRoche, G. T. Fairburn, J. W. Hallam (Babcock and Wilcox Co. Critical Experiment Lab., Lynchburg, Va.); D. R. Hostetler, and C. B. Woodhall (Babcock and Wilcox Co. Atomic Energy Div., Lynchburg, Va.). Oct. 1963. Contract AT(30-1)-2602. 97p.

Critical experiments and theoretical calculations of reactivity and flux perturbations were performed. Three major critical assemblies were studied; the basic cores had 1.206-cm diameter, aluminum clad, 2.46%-enriched UO_2 fuel rods on a square lattice pitch of 1.511 cm. Moderator compositions for the three major cores had 0, 50, and 72 mole % D_2O. Boric acid was added to keep the core radius constant at 61.11 cm. Data on a zone-loaded core with an inner zone of 93%-enriched aluminum clad UO_2-ThO_2 fuel rods surrounded by an outer zone of 4%-enriched stainless steel clad UO_2 fuel rods are also included. The moderator composition was 81% D_2O. Perturbers were introduced axially by removing fuel pins to create moderator gaps and by inserting perturbing blades and cruciform rods. The blades were 10 inches wide. The cruciform rods were 6 inches from tip to tip. The materials were Boral, cadmium, or aluminum. Most perturbers were fully inserted, but some measurements were made while the Boral cruciform rod was $\frac{1}{3}$ and $\frac{2}{3}$ withdrawn. Thermal flux distributions were measured with gold and dysprosium foils. Reactivity was determined by using $\partial\rho/\partial h$ techniques and by measuring the differential boron worth and the boron concentration required for criticality at the reference moderator height. Reactivity and thermal neutron flux shapes were calculated using PDQ-4, a four-group, two-dimensional neutron diffusion code for the Philco 2000 computer, and TKO, a four-group, three-dimensional code for the IBM-704 computer. (auth)

3170 (DLCS-3570204) REACTOR PLANT CONTAINER INTEGRITY TEST (BUTTERFLY VALVE TEST). Test Evaluation. (Duquesne Light Co., Shippingport, Penna.). First issue, Sept. 23, 1963. Contract AT(11-1)-292. 9p.

The purpose of this test was to investigate the integrity of the Reactor Plant Air Cooling System 48 inch butterfly valves by means of an air pressure test and a visual inspection. The "as found" leak rates for the supply and exhaust valves were 2.4 and 22 psi/hr, respectively. After tightening the nuts on the packing glands, the leak rates for the supply and exhaust valves were reduced to 0.4 and 1.2 psi/hr, respectively, both of which are less than the maximum allowable leak rate, 4.0 psi/hr. During the "as found" leak rate measurements on the supply valves, leakage was observed around the shaft packing. Because leakage was observed at this point, the packing gland nuts were tightened, further reducing the leakage, even though the "as found" leak rate was acceptable. (auth)

3171 (DP-865) HEAVY WATER MODERATED POWER REACTORS. Progress Report, July–August 1963. R. R. Hood, comp. (Du Pont de Nemours (E. I.) & Co. Atomic Energy Div., Wilmington, Del.). Sept. 1963. Contract AT(07-2)-1. 56p.

The HWCTR was operated intermittently during July and August at power levels as high as 38 Mw for irradiation of test fuel assemblies of uranium oxide and uranium metal. Near the end of August, a leak developed in one of the two Zircaloy bayonets in the reactor, and the reactor was shut down for examination and possible removal of the bayonet. Postirradiation examinations of UO_2 fuel tubes revealed that the outer Zircaloy sheath of four tubes that were fabricated to relatively low UO_2 density (82 to 87% of theoretical) collapsed during irradiation. Fission gas release in tubes that were irradiated to about 3000 Mwd/T ranged from 2% at $\int$ kdt values of 15 watts/cm to 60% at an $\int$ kdt of 50 watts/cm. Further evaluations of thorium-U^{233} fuel cycles in D_2O-moderated power reactors indicated that this combination offers a greater extension of uranium reserves than any converter-breeder combination proposed to date. A study of the feasibility of designing and constructing D_2O-moderated pressure tube reactors as large as 8300 Mw thermal capacity was begun. (auth)

3172 (DPST-63-69-10) EFFECT OF ROD SPACING ON HEAT TRANSFER BURNOUT. USAEC-AECL Cooperative Program Monthly Progress Report, September 1963. R. H. Towell (Du Pont de Nemours (E. I.) & Co. Savannah River Lab., Aiken, S. C.). Nov. 1963. Contract AT(07-2)-1. 6p.

A program was undertaken to determine some of the operating conditions of heavy-water-moderated power reactors. A practicable reactor would contain a minimum amount of light water poison in the fuel coolant channels. This can be achieved by operating with closely spaced fuel rods and high outlet steam qualities. The effects of these variables on the heat transfer and hydraulic characteristics of rod bundles are being studied. Measurements of the heat transfer coefficient, burnout heat flux, and pressure drop will be made on a 4-foot-long mockup of the central rod and 6 intermediate rods of a 19-rod bundle. Steam quality will be varied up to about 60% and mass flow up to about 5.0×10^6 lb/(hr)(ft^2). The effects of spacers and both vertical and horizontal orientation of the test section will also be determined. The 6-intermediate-rod mockup was shipped for plating. Preliminary skakedown tests were continued with the annular housing tube in place of the 6-intermediate-rod mockup. These tests indicated two additional equipment changes are necessary to minimize bowing of the central rod. (auth)

3173 (EUR-465.f) ÉTUDE DE LA ZONE OPTIMALE DES PARAMÈTRES INDÉPENDANTS D'UN RÉACTEUR ORGEL ASSOCIÉ A UNE CENTRALE DE 250 MWeb. ÉLÉMENTS COMBUSTIBLES EN UC GAINÉS SAP TYPE STRUCTURÉ EN GRAPPES DE QUATRE CRAYONS.

(Study of the Optimum Zone of the Independant Variables of an ORGEL Reactor Connected to a 250-MWeb Power Plant. Fuel Elements Made of UC with SAP Cladding, Structured Type with Clusters of Four Fuel Rods). F. Lafontaine and P. Tauch (European Atomic Energy Community). 1963. 53p.

The optimum range of the independent parameters for an ORGEL reactor associated with a 250-Mw power plant and using fuel elements consisting of four uc rods in clusters was determined. The parameters for two optimum power plants, differing only in coolant flow rates, are given. (D.C.W.)

3174 (EUR-476.d) STUDIE ÜBER DEN EINFLUSS DES HB-GEHALTES IM ORGANISCHEN KÜHLMITTEL AUF DIE KOSTEN DER STROMERZUEGUNG EINES 250 MWe-ORGEL-REAKTORS. (Study on the Influence of HB Contents in Organic Coolant on Electricity Production Costs in a 250-MWe ORGEL Reactor). P. Tauch (European Atomic Energy Community). 1963. 34p.

The optimum percentage of high boiling residues (HB) in organic coolant (OM-2) of a 250 Mw(e) ORGEL Power Plant and the influence on the energy production cost is determined. Independently from the radiolytic destruction rate, the HB-content ought to be less than 20%. Supposing a zero or first order rate, the optimum percentage is situated at 5% HB. (auth)

3175 (GA-2178) MARITIME GAS-COOLED REACTOR PROGRAM. Quarterly Progress Report for the Period Ending March 31, 1961. (General Atomic Div. General Dynamics Corp., San Diego, Calif. and General Dynamics Corp. Electric Boat Div., Groton, Conn.). Contract AT(04-3)-187. 203p.

The design and development of MGCR and BORE are reported. Information is presented on reactor physics, materials development, site development, rotating machinery development, fluid systems and plant arrangement, and reactor development including all components. (N.W.R.)

3176 (GA-4386) EXPERIMENTAL BERYLLIUM OXIDE REACTOR PROGRAM. Quarterly Progress Report for the Period Ending June 30, 1963. (General Atomic Div. General Dynamics Corp., San Diego, Calif.). July 31, 1963. Contract AT(04-3)-187. 64p.

The status of the development of the EBOR is reported. Information is included on reactor component development, construction, reactor physics, and materials development. (N.W.R.)

3177 (GAMD-489) THE DYNAMIC ANALYSIS OF A CLOSED-CYCLE GAS TURBINE. A. H. Stenning (General Atomic Div. General Dynamics Corp., San Diego, Calif.). Aug. 27, 1958. Contract AT(04-3)-187. 14p.

Equations for the dynamic response of a closed-cycle gas turbine to changes in input parameters are developed which are readily adaptable to a digital computer. A sample step calculation is given for a typical case. (D.L.C.)

3178 (GAMD-3712(Rev.)) MEANING OF I, p, AND RESONANCE CAPTURE RATE FOR A BROAD ENERGY BAND IN A REAL REACTOR. J. B. Sampson (General Atomic Div., General Dynamics Corp., San Diego, Calif.). Dec. 15, 1962. Contract AT(04-3)-314. 24p.

Some approaches to analysis of resonance capture phenomena are reviewed. Relations for the resonance escape probability (p) and the related resonance integral (I) are obtained for infinite media with absorption in a series of narrow resonances and for a broad energy band with no leakage. For a reactor with leakage it is then shown that several different definitions of p are possible and that the resonance band absorption rate can be normalized so that it is analogous and numerically similar to I, but not identical. Numerical values of the possible I's and p's and of the absorption and leakage rates from the resonance and slow bands are given for the HTGR critical assembly. (D.C.W.)

3179 (GEAP-4090) FORE--A COMPUTATIONAL PROGRAM FOR THE ANALYSIS OF FAST REACTOR EXCURSIONS. P. Greebler, D. B. Sherer, and N. H. Walton (General Electric Co. Atomic Power Equipment Dept., San Jose, Calif.). Oct. 16, 1962. Contract AT(04-3)-189. 142p.

The computer program FORE, which calculates transients for a fast reactor, is described. Reactor power and fuel, coolant, cladding, and structure temperatures as functions of time are calculated in response to a programmed reactivity insertion specified as a series of ramps. Temperature profiles are computed at specified axial positions for an average channel and for the peak power channel. The heat of fusion accompanying fuel melting is taken into account. Feedback reactivity coefficients that respond to temperature changes include the fuel Doppler effect and thermal expansion of core materials. The computational model, equations, data formats, flow charts, Fortran statements, and a sample case are included. (D.C.W.)

3180 (HPR-31) HBWR QUARTERLY PROGRESS REPORT, APRIL–JUNE 1963. (Norway. Institutt for Atomenergi. OECD Halden Reaktor Prosjekt). Sept. 1963. 136p.

Calibration measurements on the instrumented fuel assembly (IFA) No. 2 and 3 were completed. The integral void experiment was carried out followed by the high power cadmium-oscillator experiment. Preliminary noise and steam load experiments and the macroscopic flux distortion due to presence of void measurement were also carried out. Both the second and third instrumented fuel assemblies were commissioned and put into service. Data handling was improved by speeding up the analog-to-digital converter, putting the GIER computer into operation, and application of the Beckman analog computer for in-line data reduction as in the case of the direct reading reactivity meter. The conceptual design for the new high specific power instrumented fuel assembly IFA-4 was completed. The electrically heated boiling test loop was commissioned, the limits of electrical output were partially determined, and means for programmed electrical power oscillation were tested. (N.W.R.)

3181 (IDO-28584(Vol.I)) ARMY GAS-COOLED REACTOR SYSTEMS PROGRAM. STUDY OF MOBILE GAS-COOLED NUCLEAR POWER PLANTS. VOLUME I. PLANT DESCRIPTION. (Aerojet-General Nucleonics, San Ramon, Calif.). Sept. 1962. Contract AT(10-1)-880. 177p.

The study considered a wide variety of possible designs for a mobile gas-cooled nuclear power plant to produce 500 kw(e) for military applications. It included consideration, optimization, and selection of coolants (air, nitrogen, helium, argon, or others); thermodynamic cycles (direct open-cycle, direct closed-cycle, and dual cycles, both regenerative and non-regenerative); reactor moderators (beryllium oxide, metal hydrides, water, or no moderator); shielding (during operation and transport following operation); high-temperature materials (for reactor core, reflector, controls, shielding, structure, heat exchangers, and turbomachinery); and investigation of many other variables. Conceptual designs were completed for several

systems. The High Density Moderated Reactor System, designated HDMR, evolved as the optimum gas-cooled nuclear power plant, and is described. This concept utilizes a closed regenerative Brayton cycle with air as the working fluid. Hastelloy-X pins are used in the 16-inch diameter core; some contain UO_2 fuel and some contain yttrium hydride moderator. The hydrogen moderation provides maximum safety within acceptable shield weights. Other systems studied are also described. The HDMR offers significant advantages over existing military power plants, both nuclear and fossil fueled, in terms of logistic support requirements, mobility, reliability, and simplicity. (auth)

3182 (IDO-28584(Vol.II)) ARMY GAS-COOLED REACTOR SYSTEMS PROGRAM, STUDY OF MOBILE GAS-COOLED NUCLEAR POWER PLANTS. VOLUME II. ANALYSIS. (Aerojet-General Nucleonics, San Ramon, Calif.). Sept. 1962. Contract AT(10-1)-880. 399p.

Possible designs were considered for a mobile gas-cooled nuclear power plant to produce 500 kw(e) for military applications. Included in the study were consideration, optimization, and selection of coolants (air, nitrogen, helium, argon, or others); thermodynamic cycles (direct open-cycle, direct closed-cycle, and dual cycles, both regenerative and non-regenerative); reactor moderators (beryllium oxide, metal hydrides, water, or no moderator); shielding (during operation and transport following operation); high temperature materials (for reactor core, reflector, controls, shielding, structure, heat exchangers, and turbomachinery), and investigation of many other variables. Conceptual designs were completed for several systems. The High Density Moderated Reactor System, designated HDMR, evolved as the optimum gas-cooled nuclear power plant for military applications, and is described in detail. This concept utilizes a closed regenerative Brayton cycle with air as the working fluid. Hastelloy-X pins are used in the 16-inch diameter core; some contain UO_2 fuel and some contain yttrium hydride moderator. The hydrogen moderation provides maximum safety within acceptable shield weights. Other systems studied are also described. The HDMR offers significant advantages over existing military power plants, both nuclear and fossil fueled, in terms of logistic support requirements, mobility, reliability and simplicity. (auth)

3183 (IDO-28584(Vol.III)) ARMY GAS-COOLED REACTOR SYSTEMS PROGRAM. STUDY OF MOBILE, GAS-COOLED NUCLEAR POWER PLANTS. VOLUME III. APPENDIXES. (Aerojet-General Nucleonics, San Ramon, Calif.). Nov. 1962. Contract AT(10-1)-880. 404p.

The study considered a wide variety of possible designs for a mobile, gas-cooled nuclear power plant to produce 500 kw(e) for military applications. The study included optimization and selection of coolants; thermodynamic cycles; reactor moderators; shielding; high-temperature materials; and investigation of other variables. Conceptual designs were completed for several systems. Volume I of this report is concerned with plant descriptions; Volume II with analysis; and this volume (III) is the appendix volume, principally concerned with backup material for Volume II. (auth)

3184 (IDO-28598) ARMY GAS-COOLED REACTOR SYSTEMS PROGRAM. FINAL SUMMARY REPORT OF THE GAS-COOLED REACTOR EXPERIMENT-I. (Aerojet-General Nucleonics, San Ramon, Calif.). Oct. 1963. Contract AT(10-1)-880. 194p.

Initial criticality of the GCRE-I reactor was achieved on 23 February 1960 and testing and evaluation were continued until April 1961. The mission of the GCRE-I was the generation of neutronic and engineering data in support of the design and development of a nuclear energy source for a demonstration low-power gas-cooled, water-moderated power plant. The GCRE reactor was a heterogeneous, fully-enriched uranium-fueled unit operated in a pool of demineralized water which served as the moderator and primary radiological shield. Fuel elements were contained in a tube bundle, or calandria, which separated the fuel from the water moderator and provided passages for the gas coolant. Test operations and experimental evaluations were conducted with two core loadings of different design (one consisting of dispersion plate-type fuel elements and the other of pin-type elements) and two calandrias of similar design (one fabricated of aluminum and the other of stainless steel). A description of the facility and the test reactor, a full account of the conduct and results of the experimental program, and a discussion of the operating organization and philosophy are summarized. A bibliography of reports covering the GCRE program is presented. (auth)

3185 (IDO-28609) ARMY GAS-COOLED REACTOR SYSTEMS PROGRAM. ML-1 SHIELDING DESIGN REPORT. (Aerojet-General Nucleonics, San Ramon, Calif.). Oct. 1963. Contract AT(10-1)-880. 161p.

The shielding was designed to comply with the ML-1 performance specifications that stipulated that the biological shield should attenuate the radiation to certain specified levels within 24 hours after the reactor was shut down from full power operation. Additional shielding was to be provided as possible within the size and weight limitations to reduce levels associated with reactor operation. Preliminary designs, final design, analysis, and experiments that resulted in the final design for the ML-1 shield, as well as preliminary evaluations of shield performance, are described. (auth)

3186 (KR-50) COOLANT VOID REACTIVITY MEASUREMENTS IN A D_2O-MODERATED LATTICE WITH 7 ROD UO_2 FUEL CLUSTERS. F. W. A. Habermann (Norway. Institutt for Atomenergi, Kjeller). July 1963. 69p.

A series of measurements was carried out in the zero power facility NORA with a core of 7-rod UO_2 cluster fuel elements of the Halden Boiling Heavy Water Reactor to investigate the reactivity effect of void formation in a coolant channel. The shroud of one fuel element was subdivided into sections in which the water level could be depressed by air. The reactivity effect of voids created in this way was measured for various combinations of channels. The measured effect was always negative and largest in absolute magnitude in the center of the fuel cluster. The interaction between voided channels was such as to increase the absolute magnitude of the reactivity effects. With a first order perturbation expression based on two-group theory for an anisotropic reactor, curves were fitted to the measured reactivity effects as a function of void depth. For each case two parameters were calculated representing, respectively, multiplication and leakage properties of the lattice. It is then possible to make a comparison with lattice parameter calculations. The comparison is made only for the case of 100% void in a coolant channel by calculating the parameters for this case with the Swedish burnup 5 code. (auth)

3187 (NP-13301) O.E.C.D. HALDEN REACTOR PROJECT FOURTH ANNUAL REPORT, 1962. (Norway. Institutt for Atomenergi. OECD Halden Reaktor Prosjekt). 222p.

During the first quarter of 1962, the modification and preparatory work for operation on the second fuel charge

was completed, and the research program on the second core was started in March. A low power program was subsequently carried out to measure the excess reactivity, control rod effectiveness, and void and temperature reactivity coefficients. The reactor was brought up to a power level of 15 Mw during October, 1962. The first power measurements with the reactor were aimed at determining its transient characteristics by perturbing reactivity and steam load demand. From these measurements it was found that the reactor was very sensitive to perturbations in which the nuclear power is reduced below the power being removed by the primary heat exchangers. It was found that negative power transients were caused by moderator boiling. Since the moderator of HBWR is working at close to saturation temperature, even a small decrease in moderator pressure will result in moderator boiling. As a result of moderator flashing, the reactor was actually found to be divergently unstable at power levels above 17 Mw at maximum subcooling. In the development of a theoretical model for describing the observed instability, the uncertainties in rate of formation and distribution of flashing steam bubbles have, due to lack of experimental data, been treated parametrically in order to obtain agreement with the reactor observations. Since the long range goal of the Halden program is to assess the characteristics of large heavy-water boiling reactors, some preliminary investigation on the dynamic properties of large reactors were initiated. An analytical solution was found to the problem of space dependent kinetics. The development and in-core testing of instrumented fuel assemblies and the improvement of the data reduction system have required a major part of the development. An electrical test facility that would permit hydraulic investigations of the performance of both second charge fuel elements and new fuel elements was constructed. Test sections for the loop contain instruments identical to those used in-core. All experimental perturbation equipment was rebuilt for second charge pressures and temperatures. The new sinusoidal reactivity oscillator performed satisfactorily at power after installation of a forced air cooling system. The reactivity step generator has undergone out-of-pile commissioning. (auth)

3188 (NYO-9791) SURVEY OF COMPONENT REQUIREMENTS AND AVAILABILITY FOR GAS-COOLED NUCLEAR REACTOR POWER PLANTS. COMPRESSORS AND TURBINES. Georgs Novickis (Franklin Inst. Labs. for Research and Development, Philadelphia). Apr. 1962. Contract AT(30-1)-2512. 600p. (I-A2392-6)

The potential of closed-cycle gas turbines for producing a highly efficient nuclear power plant is discussed. Such turbines are being developed for three applications: the HTRE program (Heat Transfer Reactor Experiment) for nuclear aircraft propulsion, the MGCR program (Marine Gas Cooled Reactor) for nuclear marine propulsion, and the ML-1 (Mobile Low-Power Gas-Cooled Nuclear Power Plant) for nuclear electric power generation in an Army mobile power plant as part of the Army Gas-Cooled Reactor Systems Program (AGCRSP). Some characteristics of several non-nuclear gas turbines as well as gas turbine prime movers of 18 U.S. gas-cooled nuclear power plant projects were examined. Turbine and compressor performance, performance improvement, full-load and part-load operation, maintenance, component life, and reliability are discussed. Consideration is given to factors affecting structural integrity of turbomachinery, such as choice of proper materials, vibrations, cooling, and construction features. The material reported is based on information obtained in part from the 155 references included and in part from the data requested from some 60 manufacturers. (auth)

3189 (PRWRA-GNEC-6) BOILING NUCLEAR SUPERHEATER (BONUS) POWER STATION. Final Summary Design Report. (General Nuclear Engineering Corp., Dunedin, Fla. and Puerto Rico Water Resources Authority, San Juan). May 1, 1962. Contracts AT(40-1)-2674 and AT(40-1)-2672. 834p.

The design and construction of the Boiling Nuclear Superheater (BONUS) Power Station at Punta Higuera on the seacoast at the westernmost tip of Puerto Rico are described. The reactor has an output of 17.5 Mw(e). This report will serve as a source of information for personnel engaged in management, evaluation, and training. (N.W.R.)

3190 (SRO-95) HEAVY WATER POWER REACTOR PROGRAM MONTHLY PROGRESS REPORT, OCTOBER 1963. (Savannah River Operations Office, AEC). 9p.

Research and development progress is reported on the AEC-AECL cooperative program, CANDU Reactor development, creep-rupture properties of SAP, heat transfer and fluid flow studies, zirconium technology, metallurgy, Savannah River Components Test Reactor operation, reactor fuel elements development, Carolinas-Virginia Tube Reactor development and operation, and power reactor technology. (N.W.R.)

3191 TID-7665(p.1-12)) FUEL MANAGEMENT PROGRAM FOR THE SENN REACTOR. J. H. Crowley (Jackson and Moreland, Inc., Boston).

Fuel costs and availability effects were determined for the SENN Dual Cycle Boiling Water Reactor. Economic evaluations are confined to economics as applied in the United States and defined in the AEC cost handbook. It was found that fuel management brings about improvements in potential discharge exposure levels and in potential core power density. The fuel management programs that were considered are radial types of fuel movements with fuel being moved either from the outer periphery of the core and discharged from the center region, or conversely, moved radially from the center of the core and discharged at the outer annulus. For each of these studies, the reactor was grouped into a series of equal area radial zones with fuel being moved batchwise through these zones. An evaluation was also performed for a single-batch core wherein the entire core was discharged at the end of the reactivity lifetime. Results are shown in graphs. (M.C.G.)

3192 (TID-7665(p.13-23)) PHYSICS ANALYSIS OF FUEL MANAGEMENT IN THE SENN REACTOR. Mortimer P. Lowenfeld and Edward D. Kendrick (Allis-Chalmers Mfg. Co., Milwaukee).

An analysis was made to determine the effects of fuel management in the SENN Reactor. Nuclear constants were generated, published data on the SENN core were analyzed, varying enrichments were studied for their effects, the burnup effects over the range of enrichments were determined in terms of reactivity and fuel composition, radial fuel programing was analyzed for power distribution and fuel lifetime, and the effects of axial programing were taken into account for peak-to-average power effects. Results are presented in graphs and tables. (M.C.G.)

3193 (TID-7665(p.24-39)) FUEL CYCLE ANALYSIS OF FUEL MANAGEMENT IN THE SENN REACTOR. William E. Hayman and Fred E. Witmer (Allis-Chalmers Mfg. Co., Milwaukee).

A means of calculating fuel-cycle costs in order to be able to determine unit energy costs for specific nuclear

plants was developed. A parametric study was made based on the SENN Reactor. The basic equation for calculating total fuel-cycle unit energy cost and its derivation are shown. A computer was used to obtain a series of unit energy costs for a fuel cycle based on 5 parameters. (M.C.G.)

3194 (TID-7665(p.40-56)) PROGRESS REPORT ON FUEL CYCLE STUDIES AT MIT. Manson Benedict (Massachusetts Inst. of Tech., Cambridge).

A revised analysis was made of fuel cycle costs in the CANDU Reactor for three different methods of fuel management: continuous, bi-directional push-through fueling; simple batch irradiation; and three zone out-in fuel management. Four different ways of operating the fuel cycle for each method of fuel management were studied. Results are presented in tables. An attempt was made to handle the fuel cycle analysis of the Spectral Shift Reactor somewhat more simply than by a multigroup type of analysis. A reactor physics model was developed. The criticality equation was derived. Results are presented in tables. (M.C.G.)

3195 (TID-7665(p.82-7)) FUEL MANAGEMENT IN THE SPECTRAL SHIFT CONTROL REACTOR. L. R. Weissert (Babcock and Wilcox Co. Atomic Energy Div., Lynchburg, Va.).

Fuel management is considered, including both physics calculations and analysis in reactors and the manipulation, use, and movement of fuel in the entire fuel cycle. The study was applied to the Spectral Shift Control Reactor. Fuel costs were calculated. (M.C.G.)

3196 (TID-7665(p.88-102)) THE APPLICATION OF MULTICYCLE FUELING AND SOLUBLE POISON SHIM TO THE LARGE, CLOSED-CYCLE PWR. Robert J. French (Westinghouse Electric Corp. Atomic Power Div., Pittsburgh).

Trends in the nuclear power industry in employing advanced fuel management concepts are discussed. The first core loading for a second-generation power reactor is described. A typical power distribution contour plot for one fourth of a moderator shim core, the control rod core patterns that were obtained with the 7-8-10 loading, the variation with burnup of the nuclear hot channel factors for a rodded core that is loaded in the ratio of 7-8-10, a comparison between analytical and experimental hot channel factors that was obtained from the Yankee Power Reactor, the variation in net fuel cost with moderating ratio, the fuel cost variation as a function of moderating ratio with the constraint placed on enrichment, and the effect on hot channel factors and improvement in burnup due to cycling are shown. (M.C.G.)

3197 (WCAP-2009) 1000 MWe SUPERCRITICAL PRESSURE NUCLEAR REACTOR PLANT STUDY. First Quarterly Progress Report, January 5, 1962–March 31, 1962. (Westinghouse Electric Corp. Atomic Power Dept., Pittsburgh). May 1962. Contract AT(30-1)-2948. 144p.

The supercritical pressure heat transfer loop basic design is complete and procurement is underway. Test pressures and heat fluxes will vary from 2400 to 4000 psia and 0.2 to 1.5×10^6 Btu/hr-ft^2, respectively. Although the loop is designed for 600 kw test section heat input capability, initial tests will be limited to heat inputs of 250 kw. Conceptual design studies for the reactor portion of a 1000 Mw(e) SCOTT-R and a 1000 Mw(e) FBGR are underway. The SCOTT-R concept employs fuel inside the pressure tubes while the FBGR concept employs fuel outside the pressure tubes. (auth)

3198 (WCAP-2040) A REVIEW OF HEAT TRANSFER AND FLUID FLOW OF WATER IN THE SUPERCRITICAL REGION AND DURING "ONCE-THRU" OPERATION. A. A. Bishop, L. E. Efferding, and L. S. Tong (Westinghouse Electric Corp. Atomic Power Dept., Pittsburgh). Dec. 1962. Contract AT(30-1)-2948. 112p.

A review of heat transfer and fluid flow of water during "once-thru" operation and in the supercritical region was made as part of the work accomplished under the experimental planning phase of the 1000-Mw(e) Supercritical Pressure Nuclear Reactor Plant Study. Heat transfer, DNB, and pressure drop correlations are presented which can be used on an interim basis for the design of a reactor operating in the sub and supercritical pressure region of 1000 to 4000 psia. Values of thermodynamic and transport properties of water in the indicated pressure range and at temperatures up to 1200°F are included. Experimental heat transfer data for single cylindrical and annular test sections operating in the 2400 to 4000 psia pressure range and at temperatures up to 1200°F are included. Correlations for data are discussed. (auth)

3199 (WCAP-2070) 1000 MWe SUPERCRITICAL PRESSURE NUCLEAR REACTOR PLANT STUDY. Quarterly Progress Report No. 2, April 1, 1962–June 30, 1962. (Westinghouse Electric Corp. Atomic Power Dept., Pittsburgh). Aug. 1962. Contract AT(30-1)-2948. 171p.

The detailed design of the supercritical pressure heat transfer and corrosion test loop is complete, and loop erection is underway. Conceptual design studies comparing a 1000 Mw(e) SCOTT-R (supercritical once-thru tube reactor) with a 1000 Mw(e) FBGR (fuel bearing graphite reactor) indicate the SCOTT-R is the preferred concept with lower fuel cycle costs, lower capital costs, and a more assured feasibility in areas of overall performance, safety, fuel handling, and maintenance. A 1000 Mw(e) SCOTT-R study is underway to define more clearly its economic potential and to identify technical problem areas. (auth)

3200 (EURAEC-218) IMPROVED HEAT TRANSFER IN BOILING WATER NUCLEAR REACTORS (2ND PART). Quarterly Report No. 6, July 1–September 30, 1961. (Société Nationale d'Étude et de Construction de Moteurs d'Aviation. Division Atomiques, Suresnes, France). Oct. 1961. Work Performed under United States–Euratom Joint Research and Development Program. Contract 058-61-7-RDF. 5p. (A translation)

Heat transfer tests and loops are described for studying the application of multi-vortex type flows to boiling water reactors with square mesh assembled fuel rods (SENN type). Plans for testing are outlined. (N.W.R.)

3201 CONTROL AND INSTRUMENTATION OF FAST REACTORS. H. Jaschek. Atomwirtschaft, 8: 547-9(Oct. 1963). (In German)

Control and instrumentation of fast breeder reactors are reviewed. Dynamic stability, neutron flux control, and the safety system are discussed. It was concluded that for fast breeder reactors the dynamic stability must be guaranteed by the presence of a negative temperature coefficient. (M.C.G.)

3202 SIZEWELL—TWO YEARS' PROGRESS. Eng. Boiler House Rev., 78: 220-1(June 1963).

The status of construction of the 580-Mw Sizewell nuclear power station is summarized. Some of the unique construction equipment and procedures employed are described, and the leading particulars of the boilers, reactors, turbines, and circulators are listed. (D.C.W.)

3203 CONTROL AND TRANSIENT PERFORMANCE OF THE DRESDEN NUCLEAR POWER STATION. W. I. Collett and E. R. Owen (General Electric Co., San Jose,

Calif.). IEEE (Inst. Elec. Electron. Engrs.) Trans. Commun. Electron., No. 66, 267-77(May 1963).

Extensive control and transient performance tests were conducted on the Dresden Nuclear Power Plant and are discussed. Use of conventional plant sensors greatly facilitated obtaining transient data. Test data agree well with prior analog computations. The maneuverability and transient behavior of this boiling-water reactor plant when undergoing load changes, turbine trip-offs, and other plant disturbances establish this plant as being very satisfactory for utility applications. Stability characteristics of this reactor are excellent. (auth)

3204 INVESTIGATION OF A NUCLEAR REACTOR START-UP ACCIDENT. Y. Fishman. Sulzer Tech. Rev. (Switz.), 45: 35-9(1963).

The problems involved in a nuclear reactor start-up accident are first considered. Two analogue computing methods that permit an analysis of the problems are then put forward, using the experimental nuclear power plant at Lucens, Switzerland, serving as an example. In conclusion both the logarithmic and linear solutions are given. (auth)

3205 EBWR TRANSFER FUNCTIONS. W. C. Lipinski, C. Hsu, G. F. Popper, and A. Hirsch (Argonne National Lab., Ill.). Trans. Am. Nucl. Soc., 6: 209(Nov. 1963).

3206 NON-LINEAR AXIAL DYNAMICS OF LARGE BOILING-WATER REACTORS. R. L. Crowther and W. H. Wolf (General Electric Co., San Jose, Calif.). Trans. Am. Nucl. Soc., 6: 209-10(Nov. 1963).

3207 NUMERICAL METHOD FOR ANALYSIS OF NON-LINEAR AXIAL DYNAMICS OF LARGE BOILING-WATER REACTORS. R. L. Crowther and W. H. Wolf (General Electric Co., San Jose, Calif.). Trans. Am. Nucl. Soc., 6: 210-11(Nov. 1963).

3208 CRITICAL EXPERIMENT WITH BORAX-V SUPERHEATER ELEMENTS. K. E. Plumlee, Q. L. Baird, G. S. Stanford, and P. I. Amundson (Argonne National Lab., Ill.). Trans. Am. Nucl. Soc., 6: 217 (Nov. 1963).

3209 POWER MAPPING IN BORAX-V BOILING CORE B-2 BY FUEL-ROD ACTIVATION. Robert A. Cushman (Argonne National Lab., Idaho Falls, Idaho). Trans. Am. Nucl. Soc., 6: 218-19(Nov. 1963).

3210 CLUMPED LIGHT-WATER-MODERATED UO_2 SUPERHEAT CRITICALS: PART I. EXPERIMENTS. F. G. Warzek and H. F. Johnston (General Electric Co., Pleasanton, Calif.). Trans. Am. Nucl. Soc., 6: 219-20 (Nov. 1963).

3211 CLUMPED LIGHT-WATER-MODERATED UO_2 SUPERHEAT CRITICALS: PART II. ANALYSES. G. T. Petersen (General Electric Co., Pleasanton, Calif.). Trans. Am. Nucl. Soc., 6: 220-1(Nov. 1963).

3212 MEASUREMENTS ON HIGH-PERFORMANCE CORES FOR SMALL REACTORS. T. M. Raby, F. G. Moote, and L. D. Walthousen (AC-Schenectady, N. Y.). Trans. Am. Nucl. Soc., 6: 222-3(Nov. 1963).

3213 NON-ASYMPTOTIC LATTICE PARAMETERS IN A "DRY" UO_2 BLANKET: MEASUREMENTS AND CALCULATIONS. J. Korsmeyer, C. Emert, P. Johnson, S. Milani, J. Mitchell, R. Serenka, and S. Weiss (Westinghouse Electric Co., Pittsburgh). Trans. Am. Nucl. Soc., 6: 242-3(Nov. 1963).

3214 EXPERIMENTS WITH A HIGH SEED-FUEL DENSITY SEED/BLANKET CRITICAL ASSEMBLY. R. P. Christman, G. G. Smith, and G. F. Bogar (Westinghouse Electric Corp., Pittsburgh). Trans. Am. Nucl. Soc., 6: 248-9(Nov. 1963).

3215 EXPERIMENTS WITH A SEED/BLANKET CRITICAL ASSEMBLY WITH LARGE BLANKET-POWER FRACTION. R. F. Valentine, G. G. Smith, and R. P. Christman (Westinghouse Electric Corp., Pittsburgh). Trans. Am. Nucl. Soc., 6: 249-50(Nov. 1963).

3216 ANALYSIS OF EXCESS-REACTIVITY MEASUREMENTS IN THE HNPF. J. M. Zetterbaum (Atomics International, Canoga Park, Calif.). Trans. Am. Nucl. Soc., 6: 251-2(Nov. 1963).

3217 ANALYSIS OF CRITICAL CONTROL-ROD CONFIGURATIONS IN THE YANKEE REACTOR. W. J. Eich, H. T. Williams, Jr., J. L. Cairns, and G. H. Minton (Westinghouse Electric Corp., Pittsburgh). Trans. Am. Nucl. Soc., 6: 252-3(Nov. 1963).

3218 THE EFFECT OF FISSION-PRODUCT RECYCLE ON BURNUP IN A THERMAL REACTOR. L. J. Colby, Jr. and K. L. Mattern (Atomics International, Canoga Park, Calif.). Trans. Am. Nucl. Soc., 6: 253-4 (Nov. 1963).

3219 NUCLEAR ANALYSIS OF PM LONG-LIFE CORE 3. R. O. Bagley and Critz H. George (Martin Co., Baltimore). Trans. Am. Nucl. Soc., 6: 254(Nov. 1963).

3220 APPLICATION OF SYNTHESIS APPROXIMATIONS TO THREE-DIMENSIONAL DEPLETION CALCULATIONS AND TO CELL THEORY. S. Kaplan and O. J. Marlowe (Westinghouse Electric Corp., Pittsburgh). Trans. Am. Nucl. Soc., 6: 254-5(Nov. 1963).

3221 BREEDING POTENTIAL OF THE LIQUID METAL BREEDER (LIMB) REACTOR. Robert J. Teitel and John B. Brown, Jr. (Douglas Aircraft Co., Santa Monica, Calif.). Trans. Am. Nucl. Soc., 6: 255-6(Nov. 1963).

3222 A COMPARISON OF (PuU)C AND (PuU)O_2 FUELED FAST BREEDER REACTORS. A. Halim Kazi and Stanley Rosen (United Nuclear Corp., White Plains, N. Y.). Trans. Am. Nucl. Soc., 6: 256-7(Nov. 1963).

3223 MODERATOR SEGMENTATION: A CORE DESIGN FOR COUNTERACTING POSITIVE COOLANT COEFFICIENTS IN LARGE FAST REACTORS. R. E. Peterson and S. L. Stewart (General Electric Co., Richland, Wash.). Trans. Am. Nucl. Soc., 6: 260(Nov. 1963).

3224 BURNUP DATA FROM THREE GRADED-EXPOSURE PRTR Pu/Al FUEL ELEMENTS. D. E. Christensen, F. G. Dawson, N. W. Brown, W. A. Reardon, and W. B. Henderson (General Electric Co., Hanford, Wash.). Trans. Am. Nucl. Soc., 6: 268-9(Nov. 1963).

3225 THE POWER-CONTROL METHOD FOR SOLUTION OF DIFFUSION EQUATIONS DESCRIBING LARGE NON-LINEAR INHOMOGENEOUS REACTORS. R. L. Crowther (General Electric Co., San Jose, Calif.). Trans. Am. Nucl. Soc., 6: 276-7(Nov. 1963).

3226 PULSED-NEUTRON APPLICATION TO LARGE POWER REACTORS. P. Meyer (General Electric Co., Pleasanton, Calif.). Trans. Am. Nucl. Soc., 6: 287(Nov. 1963).

3227 FAILED-FUEL-ELEMENT LOCATION IN THE ML-1. H. S. Dreyer and H. D. Powell (Aerojet-General Nucleonics, San Ramon, Calif.). Trans. Am. Nucl. Soc., 6: 307-8(Nov. 1963).

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3232 ADVANCED DESIGNS AND SPECIAL APPLICATIONS FOR FAST REACTORS. R. Philip Hammond (Los Alamos Scientific Lab., N. Mex.). Trans. Am. Nucl. Soc., 6: 313(Nov. 1963).

3233 PHYSICAL AND CHEMICAL PROBLEMS RELATED TO AQUEOUS SUSPENSIONS AS A FUEL FOR A POWER REACTOR. J. J. Went (Keuring van Electrotechnische Materialen, N. V. Arnhem, Netherlands). Trans. Am. Nucl. Soc., 6: 315(Nov. 1963).

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3235 PM ADVANCED CORE DESIGNS. Thomas H. Cox (Martin Co., Baltimore). Trans. Am. Nucl. Soc., 6: 316-17(Nov. 1963).

3236 A WATER-COOLED THERMIONIC PORTABLE POWER PLANT. Gareth L. Reed (Martin Co., Baltimore). Trans. Am. Nucl. Soc., 6: 318-19(Nov. 1963).

3237 AN 100-kWe UNDERWATER THERMOELECTRIC REACTOR PLANT: CONCEPTUAL DESIGN. Kenneth H. Dufrane (Martin Co., Baltimore). Trans. Am. Nucl. Soc., 6: 319-20(Nov. 1963).

3238 P_4S_3-COOLED THERMOELECTRIC REACTOR PLANT: CONCEPTUAL DESIGN. Charles E. Murphy (Martin Co., Baltimore). Trans. Am. Nucl. Soc., 6: 320-1 (Nov. 1963).

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3240 MATERIAL AND DESIGN CONSIDERATIONS IN THE PM-1 REACTOR VESSEL. Rupent L. Phipps and Jacques E. Goeller (Martin Co., Baltimore). Trans. Am. Nucl. Soc., 6: 326-7(Nov. 1963).

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3251 DEVELOPMENT AND FABRICATION OF ESADA-VESR MARK II SUPERHEAT FUEL. E. A. Lees, R. F. Kirby, M. E. Snyder, and C. N. Spalaris (General Electric Co., San Jose, Calif.). Trans. Am. Nucl. Soc., 6: 356-7(Nov. 1963).

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3254 MATERIALS FOR ARGONNE NATIONAL LABORATORY SODIUM-COOLED REACTORS. R. E. Macherey, W. R. Simmons, and R. A. Noland (Argonne National Lab., Ill.). Trans. Am. Nucl. Soc., 6: 360-1(Nov. 1963).

3255 MATERIALS PROBLEMS AND SELECTIONS IN THE ENRICO FERMI FAST BREEDER REACTOR. Evan C. Kovacic, William E. McHugh, and Albert A. Shoudy, Jr. (Atomic Power Development Associates, Inc., Detroit). Trans. Am. Nucl. Soc., 6: 361-2(Nov. 1963).

3256 SELECTION AND APPLICATION OF AN AUSTENITIC STAINLESS STEEL FOR THE FABRICATION OF THE PRESSURE VESSEL FOR THE FAST REACTOR RAPSODIE. A. Guegnaud and C. Roques (Societe des Forges et Ateliers du Creusot, Paris). Trans. Am. Nucl. Soc., 6: 363(Nov. 1963).

3257 MATERIAL-SELECTION CONSIDERATIONS FOR SEFOR AND THE FCR. R. W. Lockhart and G. Billuris (General Electric Co., San Jose, Calif.). Trans. Am. Nucl. Soc., 6: 363-4(Nov. 1963).

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3259 U/10 Wt % Mo HNPF CORE I FUEL IRRADIATION STUDY. A. R. Schmitt and R. M. Willard (Atomics

International, Canoga Park, Calif.). Trans. Am. Nucl. Soc., 6: 374(Nov. 1963).

3260 IRRADIATION BEHAVIOR OF REFRACTORY-ALLOY-CLAD PLUTONIUM ALLOYS. W. N. Beck, J. H. Kittel, and R. Carlander (Argonne National Lab., Ill.). Trans. Am. Nucl. Soc., 6: 375-6(Nov. 1963).

3261 EXAMINATION OF YANKEE CORE I IRRADIATED FUEL ASSEMBLIES. L. Chajson and W. R. Smalley (Westinghouse Electric Corp., Pittsburgh). Trans. Am. Nucl. Soc., 6: 376(Nov. 1963).

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3263 FUNDAMENTAL ASPECTS OF THE DEVELOPMENT AND BEHAVIOR OF COATED-PARTICAL FUEL FOR THE DRAGON REACTOR EXPERIMENT. R. A. U. Huddle (United Kingdom Atomic Energy Authority, Winfrith, Dorset, Eng.). Trans. Am. Nucl. Soc., 6: 382(Nov. 1963).

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3265 THE DETERMINATION OF Pu-239 PRODUCTION PATTERNS IN EBR-I. R. R. Smith, R. O. Haroldsen, and R. E. Horne (Argonne National Lab., Idaho Falls, Idaho). Trans. Am. Nucl. Soc., 6: 423(Nov. 1963).

3266 PRELIMINARY EVALUATION OF THE ML-1 SHUTDOWN SHIELD PERFORMANCE. D. R. Rogers and H. O. Whittum (Aerojet-General Nucleonics, San Ramon, Calif.). Trans. Am. Nucl. Soc., 6: 429-30(Nov. 1963).

3267 OPERATIONAL AND MAINTENANCE EXPERIENCE OF THE EBR-I LIQUID METAL-COOLED REACTOR. R. O. Haroldsen, F. D. McGinnis, and G. K. Whitham (Argonne National Lab., Idaho Falls, Idaho). Trans. Am. Nucl. Soc., 6: Suppl., 2(Oct. 1963).

3268 SOME NUCLEAR CHARACTERISTICS OF NPD. C. E. Till and A. C. Whittier (Canadian General Electric, Petersborough, Ont.). Trans. Am. Nucl. Soc., 6: Suppl., 9(Oct. 1963).

3269 ML-1 POWER DETERMINATION. Robert E. Lightle (Aerojet-General Nucleonics, San Ramon, Calif.). Trans. Am. Nucl. Soc., 6: Suppl., 13(Oct. 1963).

3270 MEASUREMENT OF OPERATING PARAMETERS OF EBR-1, MARK III AND IV. F. D. McGinnis, R. O. Haroldsen, and R. R. Smith (Argonne National Lab., Idaho Falls, Idaho). Trans. Am. Nucl. Soc., 6: Suppl., 15(Oct. 1963).

3271 STAFFING OF THE ML-1 POWER PLANT WITH QUALIFIED SUPERVISORS AND OPERATORS. R. H. Chesworth (Aerojet-General Nucleonics, San Ramon, Calif.). Trans. Am. Nucl. Soc., 6: Suppl., 20-1(Oct. 1963).

3272 STAFFING & START-UP PROBLEMS— POWER BREEDER REACTOR. G. K. Whitham (Argonne National Lab., Idaho Falls, Idaho). Trans. Am. Nucl. Soc., 6: Suppl., 21-2(Oct. 1963).

3273 TRAINING OF CONSUMERS PUBLIC POWER DISTRICT PERSONNEL FOR THE OPERATION OF THE HALLAM NUCLEAR POWER FACILITY. J. S. Loomis (Atomics International, Canoga Park, Calif.). Trans. Am. Nucl. Soc., 6: Suppl., 22-3(Oct. 1963).

3274 OPERATIONAL EVALUATION OF THE AIR FORCE'S PM-1 POWER PLANT. James R. Bohannon, Jr. Trans. Am. Nucl. Soc., 6: Suppl., 27-8(Oct. 1963).

3275 ML-1 NOISE MEASUREMENTS. D. Crimmins (Aerojet-General Nucleonics, San Ramon, Calif.) and M. A. Schultz. Trans. Am. Nucl. Soc., 6: Suppl., 32(Oct. 1963).

3276 RELIABILITY IN THE HTGR SCRAM CIRCUITRY. George A. O'Sullivan (Consolidated Controls Corp., Bethel, Conn.). Trans. Am. Nucl. Soc., 6: Suppl., 33(Oct. 1963).

3277 PERFORMANCE AND RELIABILITY OF NPD. L. W. Woodhead (NPD Generating Station, Rolphton, Ont.). Trans. Am. Nucl. Soc., 6: Suppl., 37-8(Oct. 1963).

3278 OPERATING EXPERIENCE WITH RUPTURED FUEL IN THE VALLECITOS BOILING WATER REACTOR. J. B. Violette, E. L. Burley, J. C. Major, H. D. Ongman, C. M. Richards, and E. J. Strain (General Electric Co., Pleasanton, Calif.). Trans. Am. Nucl. Soc., 6: Suppl., 39(Oct. 1963).

3279 REACTIVITY CONTROL PROBLEMS IN THE PLUTONIUM-FUELED EBR-I REACTOR. R. O. Haroldsen, F. D. McGinnis, and R. R. Smith (Argonne National Lab., Idaho Falls, Idaho). Trans. Am. Nucl. Soc., 6: Suppl., 45-6(Oct. 1963).

3280 EXPERIENCE IN FABRICATION, PRESSURE TESTING AND EARLY OPERATION OF HIGH-PRESSURE HEAVY-WATER SYSTEMS AT NPD. A. C. Hoyle (Canadian General Electric, Petersborough, Ont.) and G. R. Howey. Trans. Am. Nucl. Soc., 6: Suppl., 47(Oct. 1963).

3281 DETECTION AND IDENTIFICATION OF A RUPTURED FUEL ELEMENT AT THE SM-1 (APPR-1) NUCLEAR POWER PLANT. Leo J. Misenheimer, Robert A. Purple, and Paul S. Brown ([Army Engineer School,] Engineer Reactors Group, Fort Belvoir, Va.). Trans. Am. Nucl. Soc., 6: Suppl., 49-50(Oct. 1963).

3282 POWER REACTOR TECHNOLOGY. Volume 6, No. 4. Walter H. Zinn (General Nuclear Engineering Corp., Dunedin, Fla.). 1963. $0.55(GPO) (domestic), $0.70(GPO) (foreign). (One of the Technical Progress Reviews prepared quarterly for the Division of Technical Information, USAEC). 140p.

One feature article and seven reviews are presented on the following topics: fuel utilization in the nuclear power industry, thermal neutron spectra calculations, heat transfer, CVTR, Yankee, water chemistry, nuclear superheat, and ship propulsion. Separate abstracts were prepared for all eight papers. (D.L.C.)

For abstracts of individual sections see: 1879, 2749, 3059, 3283, 3284, 3285, 3286, and 3309.

3283 EFFICIENT UTILIZATION OF NUCLEAR FUELS. J. R. Dietrich. p.1-38 of "Power Reactor Technology. Vol. 6, No. 4."

The problem of efficient nuclear fuel utilization is treated with reference to the development of converter and breeder reactors. The question of what is meant by a better converter reactor is considered. The fuel requirements of several current reactor types are estimated to the year 2030 to show how reactor characteristics affect fuel consumption. It is concluded that a problem of nuclear fuel resources does exist, and that its magnitude depends on the rate of growth and ultimate magnitude of the nuclear power industry. If estimates of the rate of growth and of uranium resources are correct, the rapid development of both breeder and converter reactors is required. Plutonium recycle in thermal converters will not solve the resource

problem, although the natural-U D_2O-moderated converter with plutonium recycle is shown to have several advantages over the H_2O-moderated converter. Finally, it is pointed out that free economic pressures alone cannot dictate reactor development in the future. (D.L.C.)

3284 DESIGN PRACTICE: THE CAROLINAS-VIRGINIA TUBE REACTOR. p.63-81 of "Power Reactor Technology. Vol. 6, No. 4."

A detailed description is given of the Carolinas-Virginia Tube Reactor, the only U. S. prototype of a D_2O power reactor. The description includes the fuel elements, fuel assemblies, control rods, pressure tubes, moderator tank, core support structure, header and jumper assembly, fuel and control program, thermal and hydraulic data, instrumentation and control, primary coolant circuit, emergency injection system, fuel handling, containment, and shielding. (D.L.C.)

3285 OPERATING EXPERIENCE: YANKEE. p.82-91 of "Power Reactor Technology. Vol. 6, No. 4."

A review is presented of the operating experience of the Yankee reactor. The problems of control rod plating failure and radioactivity release during refueling are described briefly. The purposes and problems of in-core power instrumentation are considered, and the hot-channel factors measured during the core I control-rod withdrawal program are found to agree with predictions. The reactivity characteristics are next considered, and the observed anomalous reactivity changes are described. The calculated and measured moderator temperature coefficients of reactivity are compared. (D.L.C.)

3286 NUCLEAR SUPERHEAT. p.97-105 of "Power Reactor Technology. Vol. 6, No. 4."

A brief summary is given of two design studies, one of a 200-Mw(e) integral boiling-superheating reactor and the other of a 600-Mw(e) plant which employs separate reactors for the boiling and superheating functions. The summary includes design drawings, parameters, and performance data. (D.L.C.)

3287 STAFFING REQUIREMENTS OF NUCLEAR POWER STATIONS. Giovanni B. Scuricini (CNEN, Rome). 25p. (CONF-69-14; CN 15/11)

From Conference on Operating Experience with Power Reactors, Vienna, June 1963.

The staffing requirements of nuclear power stations are discussed and the differences not due merely to different management criteria but rather to different objective reality of the power stations themselves are examined. (auth)

Production Reactors

3288 THE HIGH FLUX ISOTOPE REACTOR. C. E. Winters (Oak Ridge National Lab., Tenn.). Nucl. Sci. Eng., 17: 443-7(Nov. 1963).

The High Flux Isotope Reactor (HFIR), now being constructed at Oak Ridge National Laboratory, was designed for almost the single purpose of transmuting elements at the highest possible rate consistent with reasonable extrapolations of proven technology. The reactor is of the flux-trap type, with a cylindrical core. It is light-water cooled and beryllium reflected. At the design power of 100 Mw the reactor will produce a calculated unperturbed neutron flux of 5×10^{15} neutrons/cm^2 sec in the target region. A target of 300 gm of Pu^{242} for the production of transplutonium elements will reduce the flux to 2 or 3×10^{15}. (auth)

3289 NEUTRON MEASUREMENTS FOR CORROSION STUDIES IN LARGE REACTORS. R. B. Richman (General Electric Co., Richland, Wash.). Trans. Am. Nucl. Soc., 6: Suppl., 15-16(Oct. 1963).

3290 HANFORD REACTOR PERSONNEL CERTIFICATION. Sterling L. Nelson (General Electric Co., Richland, Wash.). Trans. Am. Nucl. Soc., 6: Suppl., 23(Oct. 1963).

Propulsion and Space

Refer also to abstract 2199.

3291 (CNLM-5202) INVESTIGATION OF CAVITATION DAMAGE OF MECHANICAL PUMP IMPELLERS OPERATING IN LIQUID METAL SPACE POWER LOOPS. Quarterly Progress Report No. 1, June 26, 1963 to September 30, 1963. R. S. Kulp and J. V. Altieri (Pratt and Whitney Aircraft Div., United Aircraft Corp. Connecticut Aircraft Nuclear Engine Lab., Middletown). Oct. 15, 1963. Contract NAS3-2541. 30p.

An investigation is being made to determine the extent of damage to an impeller operating in a known degree of cavitation in 1400°F potassium for a period of 1000 hours. Preliminary tests of the impeller in water are being conducted to confirm and extend previous hydraulic and cavitation performance data of this impeller design and to calibrate the sonic techniques for establishing the desired degree of cavitation for the liquid metal test. Design modifications to an existing turbopump (TP-1) to insure satisfactory high temperature liquid metal operation were completed. The impeller and pump shaft were machined in accordance with the design modifications. The impeller blade surfaces were hand polished to provide a finish of about 10 rms. The impeller was then checked dimensionally, and inspected for surface roughness. After installation in the Impeller Water Test Stand (PT-2), preliminary data runs showed the impeller to be pumping 700 gpm at a head rise of 200 feet at 6375 rpm. The minor changes required for the Water Pump Test Stand (PT-4) were designed and construction work on the stand has begun. Design changes for the Liquid Metal Test Stand (PT-6) were begun and some detail drawings were completed. Auxiliary equipment not required for this test was removed and controls rearranged for easier operation of the test. (auth)

3292 (CONF-311-5) A BRIEF DESCRIPTION OF THE ROVER-TYPE REACTOR, ITS INHERENT SAFETY PROBLEMS AND TEST PROGRAMS. L. D. P. King (Los Alamos Scientific Lab., N. Mex.). [nd]. Contract W-7405 eng-36. 21p.

From American Nuclear Society, Aerospace Nuclear Safety National Topical Meeting, Albuquerque, N. Mex., Oct. 1963.

The Rover type reactor is described briefly, and the problems of Rover flight safety are considered. The safety program is described in some detail, and launch pad accidents and post-operation disposal of the reactor are considered. A poison system will be used during reactor assembly and launch. (D.L.C.)

3293 (EDR-3113) SYSTEMS ANALYSIS OF NUCLEAR (SNAP II) LIQUID METAL CELL SPACE POWER SYSTEM. (General Motors Corp. Allison Div., Indianapolis). Dec. 5, 1962. 195p.

A systems analysis and conceptual design data are presented for a nuclear direct conversion space power system concept. This system is an electrochemical device based

on concentration cell principles and employing liquid metals as reactants. A detailed parametric analysis of cell performance based on current and projected technology is presented. Performance and conceptual design data on other system components, such as electromagnetic pumps, regenerator, boiler-separator, condenser, cooler, and radiator, are included. Analysis of the K–Hg liquid metal cell coupled to a SNAP II reactor is also presented. Attention is focused upon a 2-kw(e) space power system, and a detailed weight breakdown is given. (D.L.C.)

3294 (GA-2847) EXPERIMENTAL BERYLLIUM OXIDE REACTOR PROGRAM (PREVIOUSLY DESIGNATED AS THE MARITIME GAS-COOLED REACTOR PROGRAM). Quarterly Progress Report for the Period Ending December 31, 1961. (General Atomic Div. General Dynamics Corp., San Diego, Calif.). Contract AT(04-3)-187. 131p.

The status of the development of the EBOR is reported. Information is included on reactor component development, construction, reactor physics, and materials development. (N.W.R.)

3295 (GA-3005) MGCR HEAT EXCHANGER TEST PROGRAM. Final Report. H. C. Paulsen, II (General Dynamics Corp. Electric Boat Div., Groton, Conn.). Apr. 1961. Contract AT(04-3)-187. 139p.

The Maritime Gas-cooled Reactor (MGCR) project has completed the study and design of a closed-cycle gas-turbine propulsion plant utilizing a helium-cooled nuclear reactor as the heat source. The cycle employs a counter-flow shell-and-tube regenerator to attain a high thermodynamic cycle efficiency. A heat exchanger test program was conducted to compile and correlate sufficient experimental data for the aerodynamic and thermal design of the prototype regenerator. The model heat exchanger was similar in configuration to the prototype unit. The pressure-drop and heat-transfer performance of a compact parallel-flow tube bundle is given both in the unsupported configuration and with airfoil-shaped tube supports distributed along the bundle. The Fanning friction factor with the airfoil-shaped supports is approximately 70% greater than for the unsupported tube configuration. The airfoil supports effect a 40% increase in Colburn's heat transfer factor, j, over the unsupported configuration. Determinations of the unsupported-tube values of friction factor and Colburn-j agreed well with the literature. A section is devoted to the application of these data to the design of exchangers. The correlated data, representing some 1200 individual runs, cover a range of Reynolds number from 10,000 to 500,000. The moderate pressure-drop increment due to the airfoil-shaped supports, in conjunction with the favorable increase in heat-transfer rate, becomes especially important in the design of compact gas-to-gas heat exchangers with very low friction pressure losses. The concluding section of the report compares the size, weight, and cost of conventional baffled-shell units and the MGCR design for the requirements of the MGCR cycle. The MGCR design was one-fifth the volume, one-fourth the weight, and one-third the cost of comparable baffled-shell units. (auth)

3296 (NAA-SR-Memo-8817) S8DS GRIDPLATE HYDRAULICS—THERMOCOUPLE INSERTION. D. L. Whitlock (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). July 29, 1963. Contract AT-11-1-GEN-8. 33p.

Thermocouples are required in the upper grid plate for temperature measurement of the coolant. The effect on the flow rate when thermocouples were inserted into the upper grid plate of the S8DS reactor was determined. The thermocouples are to be installed by remote control; therefore, the range of depth tolerance for the thermocouple was also measured. The test demonstrated that a grid plate coolant hole counterbored to 0.215 inches diameter and to a depth of 0.150 inches would permit the insertion of a 0.125 inch diameter thermocouple to a depth ranging from 0.090 to 0.110 inches without effecting the coolant flow rate in that channel. (auth)

3297 (NAA-SR-Memo-9043) ANALYSIS OF UPPER PORTION OF NaK OUTLET PIPE. C. C. Ramptom (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). Oct. 8, 1963. Contract AT(11-1)-Gen-8. 106p.

The upper portion of the NaK outlet pipe of SNAP-2 was analyzed assuming the following loads: 1) thermal expansion, 2) in-plane loads from 30 g lateral acceleration, and 3) out-of-plane loads from 30 g lateral acceleration. The pipe was assumed to be elastically supported by the reactor top head and by a fixed bracket located about six inches below the top of the shield. This bracket was assumed fixed as to slope and roll. It was felt that when more experimental vibration test data are available that an intermediate lateral support may be required in the plane of the release band. Therefore, an analysis of this condition is also included. Critical loads on the reactor top head and brackets were calculated and summarized. A stress analysis of the pipe shows stresses to be low (9,300 psi) and the pipe to be adequate for the anticipated conditions. (auth)

3298 (ORNL-2221(Pts. 1-5)(Del.)) AIRCRAFT NUCLEAR PROPULSION PROJECT QUARTERLY PROGRESS REPORT FOR PERIOD ENDING DECEMBER 31, 1956. (Oak Ridge National Lab., Tenn.). Apr. 12, 1957. Contract W-7405-eng-26. 377p.

See ORNL-2221(Pts. 1-5) for Classified undeleted version.

The technical progress of research on circulating-fuel reactors and other ANP research is reported under the following headings: aircraft reactor engineering; chemistry; metallurgy; heat transfer and physical properties, radiation damage, and fuel recovery and reprocessing; and reactor shielding. (M.C.G.)

3299 (WA-2227(Vol.1)) EXPERIMENTAL INVESTIGATION OF HEAT REJECTION PROBLEMS IN NUCLEAR SPACE POWERPLANTS. VOLUME 1. EXPERIMENTAL EVALUATION OF HYDRODYNAMIC LOSSES IN MANIFOLDS. Period Covered: June 1, 1962 through May 31, 1963. H. L. Ornstein and H. R. Kunz (Pratt and Whitney Aircraft Div., United Aircraft Corp., Hartford, Conn.). Contract NAS3-2335. 340p.

Two-phase flow experiments were conducted using air-water mixtures to obtain data concerning pressure loss and flow distribution in radiators of direct-condensing Rankine-cycle space powerplants. The areas of study were the inlet manifold pressure drops, the manifold-to-branch pressure losses, and two-phase distribution of the flow among the branch tubes. Fourteen branch-tube inlet configurations were evaluated using single branch tubes. Two of the configurations were tested in multibranch arrangements using four in-line tubes. The effect of manifold taper was investigated. The flow in the inlet manifold was vertically downward and the branches were horizontal except for two which were at a 30-degree angle with the manifold. Manifold inlet water flow was varied from 0 to 15 per cent by weight of the inlet air flow. Other variables were: inlet manifold Mach number, 0.1 to 0.4; pressure level, 25 to 35 psia;

manifold two-phase flow pattern, mist and annular; and branch-to-manifold air velocity ratio 0.25 to 3.8. The static pressure drops in the manifold in the region of a branch tube and manifold-to-branch total pressure losses were correlated in dimensionless form useful for design calculations. At a given air flow, the effect of two-phase flow was found to be only slight on the manifold-stream pressure drops but resulted in an increase in the branch inlet losses. Both of these effects were found to be insensitive to the manifold two-phase flow patterns. A comparison of branch-inlet pressure losses for inlets that did not protrude into the manifold indicated that these losses could be greatly reduced by rounding the inlet corner. For inlets that protruded into the manifold, branch-inlet pressure losses were increased and manifold-stream pressure drops were reduced as branch protrusion decreased. The distribution of the air between the four branches was found to be virtually unaffected by the presence of liquid and the manifold two-phase flow pattern. The liquid distribution between multiple branches, however, was found to be strongly dependent upon the two-phase flow pattern in the manifold. Greater uniformity of liquid-flow distribution between multiple branches was found possible at some flow conditions by the introduction of swirl into the flow in the manifold. A tapered manifold, which provided good air-flow distribution into four rounded inlet branch tubes perpendicular to the manifold, gave good water-flow distribution for an annular two-phase flow pattern upstream of the swirl-generating device. This combination is thought to be the best of those tested when the factors of pressure loss, flow distribution, and fabrication are considered. (auth)

3300 (PWA-2227(Vol.2)) EXPERIMENTAL INVESTIGATION OF HEAT REJECTION PROBLEMS IN NUCLEAR SPACE POWERPLANTS. VOLUME 2. CONDENSING FLOW STABILITY STUDIES. Period Covered: June 1, 1962 through May 31, 1963. Sidney S. Wyde and H. R. Kunz (Pratt and Whitney Aircraft Div., United Aircraft Corp., Hartford, Conn.). Contract NAS3-2335. 105p.

A preliminary analytical study indicated that theoretically a static pressure rise could exist from the inlet manifold to the exit manifold of parallel horizontal tubes with internal condensing flow, which could reverse the condensate flow in one or more branch tubes. An experimental program was run using steam as the condensing fluid to investigate this theory. Two test configurations with parallel tubes connected to common manifolds were fabricated. One configuration consisted of metal manifolds connected by three glass tubes, each with a concentric glass cooling jacket, and the other consisted of three metal tubes with concentric metal cooling jackets mounted between two metal manifolds. The second configuration allowed higher heat extraction rates. A single metal condenser tube connecting two manifolds was used to establish a basic experimental curve of pressure difference in a tube as a function of condensing steam-flow rate at constant cooling-flow rate. Similar curves were obtained for three parallel metal tubes. The data showed that a total pressure rise could be obtained within the tube, but a static pressure loss always existed between header and collector because of larger-than-predicted pressure losses from the header to the tube inlet. Single-phase tests with air showed that tube-inlet pressure losses compared favorably with calculated values. Therefore, the large losses in the condensing tests were not caused by the geometry of the test section nor to instrumentation errors. During the single-tube tests, pressure fluctuations were observed on a pressure gage upstream of the test section, indicating that a flow instability might be occurring in the test section. A modified test section was installed to take high-speed movies of the flow in the vicinity of the final liquid-vapor interface. These movies showed that slugging was taking place within the tube and causing pressure fluctuations. These movies also indicated that the flow rate was varying within the tube, causing alternating periods of calm and turbulence in the liquid layer of the condensing section. In order to investigate the effects of slugging, tests were performed to determine the amplitude and frequency of pressure fluctuation in both single metal tube and three metal tube arrangements. Effects of condensing-flow rate, coolant-flow rate, pressure level, and a compressible volume after the test section were investigated. Tests were run with small orifices inserted inside each tube of the three tube configuration. The results showed that an increase in condensing flow caused a large increase in the amplitude of the fluctuations, whereas a decrease in coolant flow caused small decrease in amplitude. The orifices did not prove advantageous nor did a compressible volume after the test section provide any improvement for eliminating the pressure fluctuations. A three-glass-tube configuration was run to observe flow characteristics. This arrangement necessitated running at low-condensing-flow rates. A form of instability was observed in which the three interfaces underwent severe changes in location. These pulses were sporadic with a fairly calm flow pattern in the intervening period. Movies taken of this phenomenon at five times normal speed did not reveal the exact nature of the flow. A test with the glass tubes tilted slightly downward did not produce these pulses. Small quantities of air were present in the test section during this testing with three glass tubes. Because the possible instability associated with a pressure rise inside the condensing tubes was obscured by the instabilities uncovered, no experimental investigation of that phenomenon was conducted. The instabilities studied, however, must be considered in the design of a stable condenser. Further work is required to investigate the cause of these instabilities and to determine means for eliminating them. In particular, the effect of the absence of gravity on these instabilities is of great importance. (auth)

3301 (PWA-2227(Vol.3)) EXPERIMENTAL INVESTIGATION OF HEAT REJECTION PROBLEMS IN NUCLEAR SPACE POWERPLANTS. VOLUME 3. SPACE POWERPLANT STARTUP AND TRANSIENT OPERATION SIMULATION. Period Covered: June 1, 1962 through May 31, 1963. J. R. Hooper and H. R. Kunz (Pratt and Whitney Aircraft Div., United Aircraft Corp., Hartford, Conn.). Contract NAS-3-2335. 105p.

Experiments were conducted on a nuclear Rankine-cycle space power-plant simulator using water as the working fluid to determine suitable means for operating and controlling such powerplants during remotely initiated starts, and during transients resulting from changes in operating conditions. This powerplant analog simulates many aspects of the operation of a space powerplant using liquid metal working fluids and rejecting heat by radiation, and thus provides an extremely useful tool for the study of the Rankine cycle during transient and starting conditions. A two-loop powerplant system was used, consisting of an all-liquid heating loop supplied with heat by electrical Calrods simulating a nuclear reactor and a Rankine-cycle loop having a simulated direct-condensing radiator, which rejected heat by convection to a liquid trichloroethylene

stream. The facility was instrumented to study starting and transient behavior and was constructed so that a variety of starting control methods and component configurations could be tested. All the starting tests were conducted with the Rankine loop initially evacuated and the working fluid supplied from a liquid accumulator. The pressure in the accumulator was held constant at the steady-state operating value in the loop at the point the accumulator was attached. Attaching the accumulator at the power-loop pump inlet resulted in a stable system and successful starts were made. However, attaching the accumulator at the power-loop pump exit produced an unstable system during starting tests. The introduction of a pressure drop between the accumulator and the boiler was found to suppress this instability and tests were made to determine the pressure drop required for stability at different operating conditions. A successful start was then made with the accumulator at the pump outlet when a sufficiently large pressure drop was introduced. This starting technique could eliminate the need for auxiliary power to start the system. During the initial testing, the boiler was operated at 80% outlet quality, and a centrifugal separator was used at the boiler outlet to remove the liquid, which was then returned to the pump inlet. When a regenerative cooler was placed on the return line this separator system was found to operate satisfactorily during transients without the need for additional controls. A series of starting tests were conducted to measure the individual effects of various parameters using an extremely simplified system with no separator at the boiler exit and with a steady-state boiler exit superheat of 10°F. In these tests the following factors were varied: initial fill rate; steady-state flow rate; time of pump start; radiators segmented or not on start; and radiators orificed or not. The heating loop conditions, boiler steady-state inlet temperature, sink loop temperature, accumulator pressure, and accumulator location at the pump inlet were held constant. All starts with the simplified starting control system were successful except one in which the fill rate was set at 10% of the steady-state flow rate. At this very low fill rate the loop greatly overfilled with liquid and as a result the radiator pressure limitations were exceeded. (auth)

3302 SPECIFIC IMPULSE OF A LIQUID-CORE NUCLEAR ROCKET. W. Louis Barrett, Jr. (Boeing Co., Seattle). AIAA (Am. Inst. Aeron. Astronaut.) J., 1: 2649-50(Nov. 1963).

The specific impulse of a nuclear rocket engine that operates with its fission fuel in the molten state is discussed. The vapor pressures of several fission fuels are illustrated. It is concluded that the maximum specific impulse will be in the range of 1,200 to 1,400 sec. (C.E.S.)

3303 NUCLEAR PROPULSION. Robert H. Fox. Astronaut. Aerospace Eng., 1: 104-6(Nov. 1963).

Some of the present programs for nuclear-thermal propulsion development are discussed. Reactor structural and temperature requirements are the primary technical problems discussed, with payload dependence on the thrust-to-weight ratio also considered. (R.E.U.)

3304 STATUS OF ROVER PROGRAM. Frank J. Magliato (Lewis Research Center, Cleveland). Trans. Am. Nucl. Soc., 6: 300(Nov. 1963).

3305 SAFETY CONSIDERATION IN THE OPERATION OF A NUCLEAR-POWERED SPACE VEHICLE. Joanne M. Bridges and H. I. Kraig (Westinghouse Astronuclear Lab., Pittsburgh). Trans. Am. Nucl. Soc., 6: 300-1(Nov. 1963).

3306 NUCLEAR CONSIDERATIONS IN NERVA ENGINE HANDLING. Hugh C. Neale (AMF Atomics, Greenwich, Conn.). Trans. Am. Nucl. Soc., 6: 301(Nov. 1963).

3307 FACILITY DESIGN PROBLEMS ASSOCIATED WITH STATIC FIRING OF LARGE NUCLEAR ROCKET STAGES. Maxwell R. Morton (Vitro Corp. of America, New York). Trans. Am. Nucl. Soc., 6: 301-2(Nov. 1963).

3308 CAVITY NUCLEAR REACTORS. Richard J. Holl and Thomas F. Plunkett (Douglas Aircraft Co., Santa Monica, Calif.). Trans. Am. Nucl. Soc., 6: 304(Nov. 1963).

3309 SPECIFIC APPLICATIONS: SHIP PROPULSION. p.106-17 of "Power Reactor Technology. Vol. 6, No. 4."

A Maritime Administration study of the economic potential of nuclear propulsion for merchant ships gave favorable prospects. A review is presented of the features of the nuclear plants which were factored into the above study, in order to indicate trends in nuclear marine propulsion and required technological advances for the realization of the forecasts. The plants described include one gas-cooled plant (General Electric 630A) and two pressurized-water plants (Babcock & Wilcox CNSG and Combustion Engineering UNIMOD). (D.L.C.)

3310 PROPELLANT AND PRESSURANT CHARGING OF THE RIFT NUCLEAR ROCKET. Clarence A. Schalla (Lockheed Missiles and Space Co., Sunnyvale, Calif.). New York, American Society of Mechanical Engineers, 1963, Preprint Paper 63-WA-55, 9p, $1.00. (CONF-102-9)

From American Society of Mechanical Engineers 1963 Winter Meeting, Philadelphia, Nov. 1963.

The ground-support plans for the RIFT propellant and pressurant service systems are presented for the cold flow test, captive test, and launch-control operations. Countdown and abort sequences and aspects of checkout monitoring and programmed computer control are given design consideration. Cryogenic and nuclear environments relative to facility arrangements are discussed. (auth)

Research and Test Reactors

3311 (ANL-6504) SAFETY ANALYSIS OF PLUTONIUM LOADINGS IN ZPR-III. J. K. Long (Argonne National Lab., Idaho Falls, Idaho). Sept. 1963. Contract W-31-109-eng-38. 53p.

Addendum to ANL-6408.

The ZPR-III research program using 200-kg Pu is described briefly. Safety considerations were made which indicate that the Pu program is safe. The maximum accident involving a remotely credible Pu fire is estimated to release ~200 g Pu outside the ZPR-III building, with no excessive doses possible to areas beyond 11 miles. The following topics are considered in some detail: fuel design, fabrication, activity, handling, and spontaneous heating; Pu storage, containment, pyrophoricity, and air monitoring; operational procedures; temperature effects; and accident calculations. (D.L.C.)

3312 (CEA-2235) DÉTECTEUR DE RUPTURE DE GAINE POUR PILES REFROIDIES A L'EAU. (Can-Rupture Detector for Water-Cooled Piles). H. de Choudens and P. Guitton (France. Commissariat à l'Énergie Atomique. Centre d'Études Nucléaires, Grenoble). 1962. 30p.

The object of this study was to develop a simple, easy-to-build, apparatus for showing the appearance of a defect on a fuel element can of a swimming pool reactor. The apparatus used consists of a coil of activated carbon around a NaI(Tl) crystal. Through this coil pass the gases obtained by degassing a sample of water from the reactor; the fission gases which appear when a can leaks are trapped in the carbon; the NaI(Tl) crystal is coupled with a photomultiplier followed by a single-channel selector fixed on a photo-electric peak characteristic of the γ

spectrum of fission gases. Preliminary experiments were carried out in laboratory; a more complete device was then built and is now working in the reactor Melusine. (auth)

3313 (CEA-2293) GENERALITES SUR LE COMPORTEMENT DYNAMIQUE DES PILES RAPIDES. ETUDES PRÉLIMINAIRES DE RAPSODIE. (Generalities on the Dynamic Behavior of Fast Reactors. Preliminary Studies on Rapsodie). J. L. Campan, J. M. Chaumont, P. P. Clauzon, G. Ghesquiere, J. Leduc, A. P. Schmitt, and C. P. Zaleski (France. Commissariat à l'Énergie Atomique. Centre d'Études Nucléaires, Cadarache). 1963. 45p.

The methods used in theoretically investigating stability around the equilibrium power for the linear case, transients in normal reactor operation, and explosive transients are detailed and illustrated with the results obtained on a preliminary metallic core of the Rapsodie Reactor. (D.C.W.)

3314 (CEA-2307(Vol.1)) RAPPORT DE SURETÉ DE SILOE — PARTIE DESCRIPTIVE. 1er VOLUME. CHAPITRE I ET II. (Safety Report on SILOE — The Descriptive Part. Volume 1. Chapter I and II). Paul Ageron, Jean Chatoux, Guy Denielou, Michel Jacquemain, Gérard Mitault, Emmanuel de Robien, and François Rossillon (France. Commissariat à l'Énergie Atomique. Centre d'Études Nucléaires, Grenoble). 1963. 111p.

A full description is given of the site, the reactor, the building, and the experimental facilities. The nuclear, thermodynamic, and hydrodynamic characteristics of the core are given. (auth)

3315 (CEA-2307(Vol.2)) RAPPORT DE SURETÉ DE SILOE — PARTIE DESCRIPTIVE. 2^{e} VOLUME. CHAPITRES III, IV, V, VI. (Safety Report on SILOE — The Descriptive Part. Volume 2. Chapters III, IV, V, and VI). Paul Ageron, Jean Chatoux, Guy Denielou, Michel Jacquemain, Gérard Mitault, Emmanuel de Robien, and François Rossillon (France. Commissariat à l'Énergie Atomique. Centre d'Études Nucléaires, Grenoble). 1963. 175p.

The reactor control and instrumentation systems, the buildings, the reactor building ventilation system, and the electrical system of the installation are described. (D.C.W.)

3316 (CEA-2307(Vol.3)) RAPPORT DE SURETE DE SILOE — PARTIE DESCRIPTIVE. (Safety Report on SILOE — The Descriptive Part). Paul Ageron, Jean Chatoux, Guy Denielou, Michel Jacquemain, Gerard Mitault, Emmanuel de Robien, and Francois Rossillon (France. Commissariat à l'Énergie Atomique. Centre d'Études Nucléaires, Grenoble). 1963. 225p.

A hazards evaluation is given of the SILOE Reactor and its experimental facilities and site. Nuclear, thermodynamic, and hydrodynamic characteristics of the core are given for the French swimming-pool-type reactor located at Grenoble. (N.W.R.)

3317 (HW-76928) DESIGN CRITERIA FOR HIGH TEMPERATURE LATTICE TEST REACTOR PROJECT CAH-100. D. L. Ballard, W. W. Brown, C. W. Harrison, R. E. Heineman, H. L. Henry, T. W. Jeffs, G. W. Morrow, J. T. Russell, and J. K. Waite (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). May 24, 1963. Contract [AT(45-1)-1350]. 121p.

Includes Appendix.

Design and construction specifications to be followed in the development of the reactor, its associated systems and experimental facilities, and the housing and required services for the facility are presented. The testing procedures to be used are outlined. (D.C.W.)

3318 (IA-778) OPTIMIZING A NATURAL URANIUM HEAVY WATER RESEARCH REACTOR. S. Goshen, A. Pazy, and R. Thieberger (Israel. Atomic Energy Commission. Dimona Research Establishment). Sept. 1962. 12p.

The minimum core volume was found for a research reactor, subject to the following specifications: a maximum thermal flux (averaged over the cell) of 5×10^{13} neutrons/cm^2 sec; an excess reactivity of 8%; a temperature not exceeding 450°C for the hottest fuel element, and 100°C for the cooling water. (auth)

3319 (IDO-24043) SUMMARY REPORT OF DESIGN CRITERIA FOR THE LIQUID METAL PACKAGE LOOPS' HOT CELL FACILITY AND HANDLING SYSTEM AT THE ADVANCED TEST REACTOR. (Babcock and Wilcox Co. Atomic Energy Div., Lynchburg, Va. and Ebasco Services, Inc., New York). Mar. 1963. Contract AT(10-1)-1075. 389p.

Criteria work performed, prior to the termination of work on the package concept, for the liquid metal loop facilities for the Advanced Test Reactor is described. Nuclear criteria were determined for the thermal neutron filter and extended core combination in conjunction with the reference test specimen for the Fast Flux Loop. The conceptual design of the thermal loop is discussed, including the in-core section, sodium-to-helium heat exchanger, helium-to-reactor water heat exchanger, pump motor and associated bearing design requirements, preliminary shielding requirements, control system requirements, and electrical heaters within the permissible space envelope. As the criteria work progressed it was determined that despite the accomplishments, not all the program requirements could be satisfied. (M.C.G.)

3320 (IS-700(Sect.R)) REACTOR DIVISION. (Ames Lab., Ames, Iowa). 13p.

The development of the Ames Laboratory Research Reactor (ALRR) is discussed. Topics covered include: mechanical equipment and instrumentation, nuclear control and safety instrumentation, operations manual, training program for ALRR operators, and hazards summary. (M.C.G.)

3321 (ORNL-TM-662) A STUDY OF THE SHIELD OF THE UNIVERSITY OF VIRGINIA NUCLEAR RESEARCH REACTOR. T. V. Blosser and R. M. Freestone, Jr. (Oak Ridge National Lab., Tenn.). Nov. 25, 1963. Contract W-7405-eng-26. 19p.

The fast neutron and gamma-ray dose rates and the thermal neutron fluxes existing at the face of the biological shield of the pool-type reactor were carefully measured. Similar data were also obtained at the surface of the pool. Dose rates and fluxes were generally low, although some streaming around thermal column and access facility closures was observed. Other data obtained included measurements of dose rates at various points in the vicinity of the reactor coolant water heat exchanger, a controlled area during reactor operation. (auth)

3322 (TID-7663) CONFERENCE ON LIGHT-WATER-MODERATED RESEARCH REACTORS, HELD AT GATLINBURG, TENNESSEE, JUNE 11-14, 1962. (Oak Ridge National Lab., Tenn.). Contract W-7405-eng-26.

Thirty-seven papers presented at the Conference on Light-Water-Moderated Research Reactors and discussions following the papers are given. Separate abstracts

were prepared for 23 papers. Fourteen papers were previously abstracted in NSA. (M.C.G.)

For abstracts of individual papers see: 3323, 3324, 3325, 3326, 3327, 3328, 3329, 3330, 3331, 3332, 3333, 3334, 3335, 3336, 3337, 3338, 3339, 3340, 3341, 3342, 3343, 3344, and 3345.

3323 (TID-7663(p.1-60)) START-UP OF THE R.C.N. HIGH FLUX REACTOR; LOW POWER TEST RESULTS AND FIRST OPERATING EXPERIENCE. J. H. B. Madsen and S. H. Woldringh (Reactor Centrum Nederland, The Hague).

The R.C.N. (Netherlands Research Center) materials testing and research reactor is of the ORR-type with nominal thermal power of 20 Mw. The high-flux reactor core consists of a square lattice with 81 positions arranged in a 9 × 9 array. The initial critical core was comprised of 10 fuel elements (125 g U^{235} each) and 4 control rods (91.5 g U^{235} each with cadmium poison section) and was fully reflected by beryllium elements. The critical mass was about 1619 gram U^{235}. This core was built out to a 5 × 7 core, which has one side against the core box wall at the poolside facility. Two-dimensional two-group calculations for the 5 × 7 core predicted an excess reactivity of about 15% Δ k/k. The control rod calibration data indicated that the actual excess reactivity is much lower, about 9% Δk/k. The results of the low power post-neutron tests are reported, including control rod worths, flux data, temperature- and void-coefficients, and fuel element worths. Attention was given to problems encountered during the operation, from the beginning of the testing out of the installation. Minor modifications of the installation and accessories which proved helpful for operation of the reactor are summarized. (auth)

3324 (TID-7663(p.61-72)) SOME EXPERIENCES FROM THE OPERATION OF THE SWEDISH LIGHT WATER MODERATED REACTORS R2 AND R2-0. Kjell Johansson, K. Saltvedt, and R. Skjoeldebrand (Aktiebolaget Atomenergi, Studsvik, Sweden).

The design and operation of the Swedish light-water-moderated, highly enriched reactor R2 are discussed. The core, instrumentation, experimental facilities, secondary cooling system, and containment system are described. The pool reactor R2-O is also discussed. The experimental program is described. (M.C.G.)

3325 (TID-7663(p.145-60)) JEN-1 SWIMMING POOL REACTOR. J. Montes Ponce de León, L. Mañas Díaz, M. Enríques de Salamanca, E. Artacho Savirón, M. Fajardo Cantillo, M. Balseyro Castro, and J. Perez Sánchez.

The design of the Spanish swimming-pool reactor, JEN-1, is described. Startup and calibrations are discussed. Operation and experimental programs are described. Drawings and graphs are presented. (M.C.G.)

3326 (TID-7663(p.161-81)) OPERATIONAL EXPERIENCE WITH THE HARWELL REACTOR LIDO. C. J. England.

A description is given of LIDO, a 100-kw light-water-moderated reactor designed primarily for studies on bulk shielding materials and for experiments in nuclear and reactor physics which require large stacks of moderators or multiplying systems. The reactor pool is contained in a concrete tank whose walls are entirely above ground. These walls are cut away at three places and replaced by thin aluminium panels to give large spaces into which complete sections of prototype shields, moderator stacks, or sub-critical lattice systems may be built. The core can be moved in a horizontal plane so as to rest opposite any of these panels or at the end of any of three beam holes. Some modifications were made to the reactor as a result of experience gained during 5½ years of operation. These and the problems which it is anticipated would be encountered if the normal operating power were to be raised above the original design value are discussed. The reactor is operated according to a set of procedures designed to give maximum safety at all times. Details of these procedures and of the status and training of the staff who perform them are given. The maintenance philosophy and some problems which arose in the maintenance of the reactor and in the chemical control of the water are reviewed. A variety of experiments were performed at both the large panels and the beam holes and in the core. The problems associated with an in-core irradiation experiment in a reactor of this type are discussed. (auth)

3327 (TID-7663(p.182-230)) IRL REACTOR FACILITY DESCRIPTION AND OPERATING HISTORY. T. C. Weeks, B. S. Maxon, and R. W. Houston (Industrial Reactor Labs., Inc., Plainsboro, N. J.).

The IRL reactor is an open-core, pool-type research reactor designed for routine operation at powers in excess of one megawatt. The reactor is an assembly of MTR design fuel components, controlled by boron carbide-cadmium rods and cooled by the gravity flow of water from the pool in which the reactor is operated at a maximum of 5 Mw(t). The reactor is housed in a dome-shaped, reinforced-concrete building. A description of the reactor and its associated systems and experimental facilities, a history of the startup and test program and two years of 5 Mw operation, a recapitulation of significant operating problems, and discussions of innovations in operating devices are presented. (auth)

3328 (TID-7663(p.231-48)) OPERATION EXPERIENCE WITH THE ASTRA-REACTOR. A. O. Burtscher.

The ASTRA reactor, part of the Austrian Research Center, Seibersdorf, is a swimming-pool-type research reactor. The nominal power level is 5 Mw, however, provisions are made for an increase to 12 Mw. The reactor building is a cylindrical concrete shell, 26 m dia and 25 m high. It was designed to withstand an overpressure of approximately 0.5 psi. The outside of the building is covered with a heat insulation material and aluminum sheets. The experimental facilities are described. Operational experience is reviewed. The fuel elements, experiments with split core configurations, instrumentation and control, training of reactor operators, and the emergency power system are discussed. (M.C.G.)

3329 (TID-7663(p.249-66)) SEVEN YEARS OF OPERATING A REACTOR FOR EDUCATION AND RESEARCH. Edward S. Kenney, Forrest J. Remick, and Gordon E. Robinson (Pennsylvania State Univ., University Park).

Seven years of operation indicated that a research reactor can be a valuable addition to the research and education capabilities of a university. Experience at the Penn State Reactor showed that education, training, and research can be integrated into a university program. Operating problems must be solved by methods consistent with the safe operation of the facility, but without unreasonably restricting the use of the reactor. In the underlying concept of operating a reactor on a university campus, flexibility and versatility are considered extremely important. Rather than designing and building into a reactor facility that which appears desirable at the moment, it is considered more important to insure that the design allows for the performing of the greatest possible

variety of experiments. This same policy is considered best also in the education and training programs. (auth)

3330 (TID-7663(p.267-74)) OPERATING EXPERIENCE WITH THE UNIVERSITY OF VIRGINIA REACTOR. J. L. Meem (Virginia. Univ., Charlottesville).

Operating experience with the University of Virginia Reactor is summarized. Only two major problems arose in operation; swelling of the boron carbide control rods and leaks in the all-aluminum heat exchanger. Minor problems and their solutions and design features are discussed. (M.C.G.)

3331 (TID-7663(p.275-86)) ON THE HITACHI TRAINING REACTOR (HTR). Shoichi Terasawa (Hitachi, Ltd. Central Research Lab., Tokyo).

The Hitachi Training Reactor, HTR, is a 100 kw pool-type reactor with 10% U^{235}-enriched UO_2 pellet fuels instead of the usual MTR-type fuel elements. The basic design principles and features are described from the point of reactor physics. Three independent criticality calculations were performed and compared to predict the most probable critical mass and necessary fuel inventory. (M.C.G.)

3332 (TID-7663(p.287-335)) ADMINISTRATION OF ORNL RESEARCH REACTORS. W. R. Casto.

Administration of the operation of the Oak Ridge Research Reactor (ORR), the Low Intensity Testing Reactor (LITR), and the Oak Ridge Graphite Reactor is described. Manpower, organization, development and revision of operating procedures, distribution of internal information of temporary importance, administrative control of safety, costs of reactor operations, and administrative control of radioactive waste are discussed. (M.C.G.)

3333 (TID-7663(p.336-52)) SOME ADMINISTRATIVE CONTROLS PRACTICED IN MTR OPERATIONS. E. H. Smith (Phillips Petroleum Co. Atomic Energy Div., Idaho Falls, Idaho).

As an aid in evaluating shift crew performance, MTR operations conducts a continuous internal audit of reactor and experiment operation by examining logbooks, charts, and other operating data for completeness, accuracy, and adherence to operating instructions and procedures. Any omission of data, operational errors, and inconsistencies are chargeable to the operating shift involved. All such observations chargeable are correlated by statistical means to establish upper and lower control limits for satisfactory performance. Specific job knowledge and safe operating procedures are promoted by the use of training guides for the positions of reactor engineer, senior reactor engineer, and shift foreman. These guides require each individual to perform all jobs within his classification on a "tell and do" basis for his immediate supervisor. (auth)

3334 (TID-7663(p.353-67)) THE RELATIVE IMPORTANCE OF DESIGN AND ADMINISTRATIVE CONTROL IN THE SAFETY OF MEDIUM POWER REACTORS M. C. J. Todd (United Kingdom Atomic Energy Authority. Weapons Group. Atomic Weapons Research Establishment, Aldermaston, Berks, England).

The safety of pool research reactors in the power range 1 to 5 Mw is considered. Special attention is paid to the possibility of burnout due to flow instability when the reactor core is cooled by downward coolant flow. (auth)

3335 (TID-7663(p.386-402)) REACTOR OPERATOR TRAINING AT THE MTR-ETR. W. J. Byron (Phillips Petroleum Co. Atomic Energy Div., Idaho Falls, Idaho).

In May 1960, the first formal training program for MTR-ETR reactor and experiment operators was inaugurated. There are three phases in the program: classroom lectures, on-the-job training, and qualification. (M.C.G.)

3336 (TID-7663(p.436-51)) EXPERIENCE OF PAKISTANIS PARTICIPATING IN NUCLEAR TECHNOLOGY TRAINING IN THE UNITED STATES, AND ITS USE IN THE PAKISTAN ATOMIC ENERGY PROGRAM. M. N. Alam (Pakistan. Atomic Energy Centre, Lahore).

The theoretical training and experimental work carried out by Pakistanis in courses in reactor technology and research in reactor kinetics in the United States are described. The knowledge gained is expected to be utilized in the installation and use of a 5-Mw pool-type research reactor and associated laboratories. (M.C.G.)

3337 (TID-7663(p.531-84)) EXPERIMENTAL PROGRAMME WITH THE R.C.N. HIGH FLUX REACTOR. J. J. M. Snepvangers.

The Netherlands Research Center high-flux reactor is described and diagrams are given. Experiments for irradiation of UO_2 fuel, a pressurized-water loop for fuel element testing, a graphite irradiation experiment, steel irradiations without temperature control, a steel irradiation facility with temperature control, and physics experiments in neutron beams are discussed. (M.C.G.)

3338 (TID-7663(p.700-14)) PROMOTING THE UTILIZATION OF A REACTOR ON A UNIVERSITY CAMPUS. Forrest J. Remick, Edward S. Kenney, and Gordon E. Robinson (Pennsylvania State Univ., University Park).

Criteria for gaging successful utilization of a reactor on a university campus are discussed. Topics covered include: establishing the need for a reactor, determining if a facility is being used, history of the Penn State Reactor, separation of staff, budgeting, working environment, and promotional activities. (M.C.G.)

3339 (TID-7663(p.715-37)) INSTALLATION AND MAINTENANCE OF HIGH-PRESSURE WATER LOOPS IN MTR-ETR. L. W. Scarbrough (Phillips Petroleum Co. Atomic Energy Div., Idaho Falls, Idaho).

The five high-pressure water loops (2200 psi, 600°F) presently installed in the MTR are located in horizontal beam holes that do not penetrate the reactor core and in reflector positions within the reactor vessel. All nine high-pressure water loops in the ETR are located within the reactor core or reflector positions. The design of these test facilities as well as required modifications is the basic responsibility of the customer. All designs are reviewed by Phillips prior to installation of the facility. Installation and modification work is performed by Phillips Maintenance and Experiment Services Branch personnel. A thorough dimensional inspection is made of all inpile tubes prior to insertion in the reactor. Primary loop high-pressure pipe welding is done by the inert-gas-shielded metal-arc process using filler piece E-B rings with each joint being radiographed before acceptance. Generally, all instrument control panels are received pre-wired with necessary inter-connecting tubing and wiring installed by Phillips. All parameter measurements that may initiate reactor power reductions are double tracked to the reactor control relays. Loop instrumentation is predominately of the pneumatic variety. This type instrumentation lends itself to a built-in alarm and reactor control setpoint checking system for verifying the settings of the numerous setpoints during shutdown periods. High-pressure water loop equipment is operated for approximately one month prior to inserting the inpile tube to de-bug the equipment and control systems as well as provide operator training.

At the time the inpile tube is installed in the reactor and prior to operation of the reactor, extensive flow coast down tests are run to determine reactor control setpoints from the performance of the instrument systems. Numerous modifications from simple additions to inpile tube changeouts occur each reactor shutdown. The radiation exposure to personnel to accomplish this work is an increasing problem. Planned or preventive maintenance programs are in use for all plant, reactor, and experiment equipment. (auth)

3340 (TID-7663(p.738-89)) LOW POWER EXPERIMENTS WITH "DEMOCRITUS" NUCLEAR REACTOR. George Andritsopoulos, Nicholas Chrysochoides, Constantine Mitsonias, and Neophytos Papadopoulos (Greece. Atomic Energy Commission. "Democritus" Nuclear Research Center, Athens).

Experiments carried out with the Greek reactor "Democritus," a 1-Mw pool-type research reactor, are described. Two methods for the critical experiment are given for comparison. One is the conventional method; the other is a calculational method permitting the exact predictions not only of the loading step at which criticality will be reached but also of the shim and regulating rod position at criticality. From the formula used a direct method of integral rod calibration was derived and compared to the conventional pile period method. Various core configurations and flux mapping of the core was given. (M.C.G.)

3341 (TID-7663(p.842-54)) SPECIAL PROBLEMS RAISED BY FULL-TIME OPERATION OF THE 2-MW SWIMMING-POOL REACTOR AVOGADRO RSI. E. Pedretti and G. Szabò Miszenti (Società Ricerche Impianti Nucleari, Centro Ricerche Nucleari, Saluggia, Italy).

Solution of problems for full-time operation of the 2-Mw swimming-pool reactor, Avogadro RSI, are reported, with particular regard to elimination of control rod oscillation caused by water flow and choice of peculiar operating conditions required by modification of some control elements. (auth)

3342 (TID-7663(p.855-8)) COMPARISON OF ROD WORTH BY PERIOD AND ANALOG COMPUTER METHODS. Cesar Sastre (Brookhaven National Lab., Upton, N. Y.) and Hector Barcelo (Puerto Rico Nuclear Center, Mayagüez).

The results of two methods of calibrating the rods of the Puerto Rico Nuclear Center 1-Mw reactor were compared. First the rod worth was obtained by the period method. Then a method using an analog computer was used. A percent of error of 0.95% was shown between the values obtained by the two methods. (M.C.G.)

3343 (TID-7663(p.859-63)) ELIMINATION OF CONTROL ROD VIBRATION CAUSED BY WATER FLOW. Hector Barcelo (Puerto Rico Nuclear Center, Mayagüez).

The control system for the 1-Mw Puerto Rico Nuclear Center swimming-pool reactor consists of four shim rods supported by electromagnets and one regulating rod suspended by a bar that connects to the driving mechanism. A period vibration trace from +30 to –30 sec appeared on the log N period chart recorder. The vibration was found to be produced by hydraulic disturbance on the rod channels. Two adjustment screws for each of the four shim rods were installed in the magnet armature. For the regulating rod, a guide was installed that would fit tight to the connecting bar and slide against the guide tube. (M.C.G.)

3344 (TID-7663(p.948-1013)) METHODS OF TESTING THE NASA PLUM BROOK REACTOR FOR ITS HYDRAULIC CHARACTERISTICS. Joseph M. Savino and C. D. Lanzo.

The basic objectives of the hydraulic testing program were to determine in detail the flow characteristics of the reactor core and reflector regions and to correct any flow anomalies uncovered during the testing. Detailed information is given on the instrumentation and techniques employed to accomplish the program aims. Many test results are presented including a discussion of a flow problem which was encountered and the changes which corrected it. Once the modifications were made, the flow distributions were in excellent agreement with the design coolant flow rates for full power and shutdown operations. Other results, and conclusions of importance to proper reactor cooling and flow testing are discussed. (auth)

3345 (TID-7663(p.1060-92)) DETECTION OF FISSION PRODUCTS RELEASED FROM FUEL ASSEMBLIES IN A POOL-TYPE REACTOR. Boyd S. Maxon (Industrial Reactor Labs., Inc., Plainsboro, N. J.).

A technique was investigated for the detection of fission product release from individual fuel assemblies in a reactor core while operating at a high power level. This technique consists of a special probe, and auxiliary equipment, which is designed to strip inert fission product gases from water discharging from the individual fuel assemblies, and to remove these fission products and/or their particulate daughters from the strip gas for subsequent analysis. The special probe is operated on the air-lift principle using nitrogen gas as the lifting and stripping media. This technique has been used in the IRL reactor while operating at 5,000 kw, to locate a fuel assembly which has released above normal levels of fission products. During the series of tests conducted, both charcoal and absolute filters were used for the fission product collection media. Although the gross collection effectiveness of the absolute filters is less than for the charcoal filters, the absolute filter is preferred since nuclides with long half lives such as Xe^{135} and Ar^{41} are not collected. The detection method investigated is deemed adequate for anticipated use in the IRL and similar open pool type reactor systems, and may be adapted to other reactor systems which have shorter coolant cycle times. (auth)

3346 (UCRL-7477) RHOBURN: A NUCLEAR REACTOR CODE FOR CALCULATING BURNUP AND OPERATIONAL PARAMETERS FOR THE LPTR. Gordon V. Pefley, Jr. (California. Univ., Livermore. Lawrence Radiation Lab.). Aug. 20, 1963. Contract W-7405-eng-48. 41p.

The RHOBURN program that determines various parameters for the Livermore Pool Type Reactor using a matrix of 840 cells, stored in two-dimensional form, is described. The code calculates the burnup of U^{235} on the basis of the megawatt days run during a fuel cycle and as a function of the neutron flux and fuel inventory in each of the 840 homogeneous cells in the reactor core. The thermal utilization and various other parameters for each core, and values for calculating the reactivity change between different cores can also be obtained. RHOBURN is written in Fortran for the IBM 7094, to be run under monitor control. The program listing and sample input and output are included. (auth)

3347 GEOMAGNETIC EFFECTS OF EXPLOSIONS IN THE LOWER ATMOSPHERE. K. G. Ivanov (Inst. of Terrestrial Magnetism, Ionosphere, and Radiowave Propagation, Academy of Sciences, USSR). AIAA (Am. Inst. Aeron. Astronaut.) J., 1: 2703-8(Nov. 1963).

The results of work on the study of geomagnetic effects

in the lower atmosphere (below 80 km) are reported. It is assumed that the initial changes of the field in the geomagnetic effect due to the explosion near Christmas Island were caused by the penetration through the ionosphere of a shock wave formed as a result of that explosion, whereas the shock waves of the explosions over Johnston Island induced a strengthening of the field upon penetration through the F layer of the ionosphere. The delay time of the variation after the explosion near Christmas Island was equal to the time of penetration of the shock wave from the location of the explosion (about 10^5 cm over the earth's surface) to the E layer of the ionosphere. The speed of the shock wave is taken equal to about 3.3×10^4 cm/sec. The time of penetration of shock waves from the point of the explosions over Johnston Island to an altitude of about 200–300 km is fixed according to a formula for a point explosion in an inhomogeneous atmosphere, and turns out to be equal to 1-2 min for the explosion of August 1, 1958, and 2-9 min for the explosion of August 12, 1958, which agrees with the delay of positive impulses as observed, equal, respectively, to 2.0 and about 5 min. (auth)

3348 THE ENERGY SPECTRUM OF A HIFAR NEUTRON BEAM. T. M. Sabine, J. D. Browne, and J. L. Symonds (Australian Atomic Energy Commission Research Establishment, Lucas Heights, New South Wales). Australian J. Appl. Sci., 14: 270-1(Sept. 1963). (AAEC/TM-172)

The energy spectrum for a beam of neutrons from the Australian High-Flux Reactor, HIFAR, was determined. The neutrons in the beam were taken from a point in the heavy-water moderator 9.5-in. from the edge of the reactor core, and the neutron flux emerging at the reactor shield face was 2×10^8 neutrons cm^{-2} sec^{-1} for a reactor power of 10 Mw. Crystal spectrometry and activation analysis were used to determine the energy spectra. (C.E.S.)

3349 THE SCOTTISH RESEARCH REACTOR CENTER. H. W. Wilson (Scottish Research Reactor Center, East Kilbride, Eng.). Scottish Eng. Students' Assoc. J., 22-5; 39(1963).

The expanding use of nuclear power and radioisotopes is cited as the basis for interest in the nuclear field; and the research center, particularly the reactor, is described. The proposed activities of the center are indicated. (D.C.W.)

3350 RESULTS OF INITIAL EXPERIMENTS ON THE CORNELL ZERO-POWER-REACTOR CORES. H. C. Aderhold, S. S. Berg, D. D. Clark, E. B. Fehr, and R. A. Shaw (Cornell Univ., Ithaca, N. Y.). Trans. Am. Nucl. Soc., 6: 223-5(Nov. 1963).

3351 BR2 EXPERIENCE—COMPARISON BETWEEN DESIGN AND OPERATION. D. Rush (Centre d'Etude de l'Energie Atomique, Fontenay-aux-Roses, France), A. H. Kazi, K. J. Bobin, and F. Motte. Trans. Am. Nucl. Soc., 6: 246(Nov. 1963).

3352 MEASUREMENT OF k_∞ AND OTHER PARAMETERS IN EPITHERMAL LATTICES BY SLE TECHNIQUE. N. L. Snidow, D. M. Roberts, G. T. Fairburn, and T. C. Engelder (Babcock & Wilcox Co., Lynchburg, Va.). Trans. Am. Nucl. Soc., 6: 246-7(Nov. 1963).

3353 THE DETERMINATION OF k_∞ FROM MEASUREMENTS ON A SMALL TEST SAMPLE IN A CRITICAL ASSEMBLY. D. D. Lanning, R. E. Heineman, I. Kaplan, and T. J. Thompson (Massachusetts Inst. of Tech., Cambridge). Trans. Am. Nucl. Soc., 6: 247-8(Nov. 1963).

3354 PRECISELY TIMED INITIATION OF A FAST BURST REACTOR. K. L. Haynes and P. D. O'Brien (Sandia Corp., Albuquerque, N. Mex.). Trans. Am. Nucl. Soc., 6: 284(Nov. 1963).

3355 ANALYSIS OF THE CERENKOV LIGHT IN A WATER–MODERATED REACTOR. R. Madey and D. Duffey (Univ. of Maryland, College Park). Trans. Am. Nucl. Soc., 6: 307(Nov. 1963).

3356 PRESSURE PULSES IN RAPID TRANSIENT BOILING. R. W. Wright (Space Technology Labs., Inc., Redondo Beach, Calif.). Trans. Am. Nucl. Soc., 6: 338-9 (Nov. 1963).

3357 FUEL MANAGEMENT FOR AN INTERMEDIATE-POWER RESEARCH REACTOR. Ernest E. Hill (Univ. of California, Livermore). Trans. Am. Nucl. Soc., 6: Suppl., 1(Oct. 1963).

3358 CASTING AN EPOXY RESIN TO REPAIR A HEAVY-WATER LEAK IN THE NRU REACTOR. Norman E. Brown (Atomic Energy of Canada Ltd., Chalk River, Ont.). Trans. Am. Nucl. Soc., 6: Suppl., 6-7(Oct. 1963).

3359 CONTROL-ROD CALIBRATIONS USING AN ANALOG COMPUTER. F. R. Allenspach (Brookhaven National Lab., Upton, N. Y.). Trans. Am. Nucl. Soc., 6: Suppl., 8-9(Oct. 1963).

3360 CANADA INDIA REACTOR OPERATING EXPERIENCE: REACTOR PHYSICS. N. Veeraraghavan, D. B. Upendra, and R. Narain (Atomic Energy Establishment, Trombay, India). Trans. Am. Nucl. Soc., 6: Suppl., 9-10(Oct. 1963).

3361 PREDICTING EXCESS REACTIVITY IN THE ETR AS A FUNCTION OF POWER-TIME. J. W. Henscheid and E. E. Burdick (Phillips Petroleum Co., Idaho Falls, Idaho). Trans. Am. Nucl. Soc., 6: Suppl., 10-11(Oct. 1963).

3362 CONTROL-ROD CALIBRATION AND XENON-POISONING EXPERIMENTS AT THE LIVERMORE POOL-TYPE REACTOR. Stephen A. Massey (Univ. of California, Livermore). Trans. Am. Nucl. Soc., 6: Suppl., 11-12 (Oct. 1963).

3363 APSARA REACTOR OPERATING EXPERIENCE: REACTOR PHYSICS. N. Veeraraghavan, D. B. Upendra, and R. Narain (Atomic Energy Establishment, Trombay, India). Trans. Am. Nucl. Soc., 6: Suppl., 12(Oct. 1963).

3364 OPERATIONAL PHYSICS DATA FROM THE HWCTR. B. C. Rusche (E. I. du Pont de Nemours & Co., Aiken, S. C.). Trans. Am. Nucl. Soc., 6: Suppl., 13-14 (Oct. 1963).

3365 EXPERIMENTAL MEASUREMENTS OF FUEL-ELEMENT OPERATING PARAMETERS IN THE DIDO-CLASS REACTORS UNDER NORMAL AND FAULT CONDITIONS. Roy Panter (Atomic Energy Research Establishment, Harwell, Berks, Eng.). Trans. Am. Nucl. Soc., 6: Suppl., 14-15(Oct. 1963).

3366 DESIGN AND OPERATION OF AN INEXPENSIVE COOLING SYSTEM FOR A POOL REACTOR. H. J. Worsham, Jr. (Babcock & Wilcox Co., Lynchburg, Va.). Trans. Am. Nucl. Soc., 6: Suppl., 17(Oct. 1963).

3367 THE RESEARCH REACTOR AS A GAMMA SOURCE. William F. Hall, Charles C. Thomas, and Ralph F. Lumb (Western New York Nuclear Research Center, Inc., Buffalo). Trans. Am. Nucl. Soc., 6: Suppl., 17-18 (Oct. 1963).

3368 STAFFING EXPERIENCE FOR OPERATION OF THE PLUTONIUM RECYCLE TEST REACTOR. D. R. Koberg (General Electric Co., Richland, Wash.). Trans. Am. Nucl. Soc., 6: Suppl., 20(Oct. 1963).

3369 PREPARATION FOR OPERATION OF THE HFIR. R. V. McCord (Oak Ridge National Lab., Tenn.). Trans. Am. Nucl. Soc., 6: Suppl., 22(Oct. 1963).

3370 DESIGN REVIEW AND SAFETY ANALYSIS OF EXPERIMENTS IN ORNL RESEARCH REACTORS. I. E. Stanford and R. A. Costner, Jr. (Oak Ridge National Lab., Tenn.). Trans. Am. Nucl. Soc., 6: Suppl., 25-6(Oct. 1963).

3371 SECONDARY AND TERTIARY CONTAINMENTS TO THE WRRR. J. B. Smathers and Dan Hightower (Walter Reed Army Medical Center, Washington, D. C.). Trans. Am. Nucl. Soc., 6: Suppl., 26-7(Oct. 1963).

3372 SOME SAFETY ASPECTS OF RESEARCH REACTOR OPERATION. R. Skjoeldebrand (International Atomic Energy Agency, Vienna). Trans. Am. Nucl. Soc., 6: Suppl., 29(Oct. 1963).

3373 ADMINISTRATION PROBLEMS OF RESEARCH REACTOR OPERATION. W. H. Lunning (Dounreay Experimental Research Establishment, Thurso, Caithness, Scotland). Trans. Am. Nucl. Soc., 6: Suppl., 29-30(Oct. 1963).

3374 EXPERIENCE WITH ELECTRONIC EQUIPMENT AT CIR. S. Srinivasan and S. Ramaswamy (Atomic Energy Establishment, Trombay, India). Trans. Am. Nucl. Soc., 6: Suppl., 35(Oct. 1963).

3375 OPERATIONAL EXPERIENCE OF THE SALUGGIA SWIMMING POOL REACTOR CONTROLLED BY A SOLUBLE-POISON CLOSED-LOOP AUTOMATIC CONTROL SYSTEM. G. Ambrosini, T. Bozzoni, and G. Cipollina (Comitato Nazionale per l'Energia Nucleare, Rome). Trans. Am. Nucl. Soc. 6: Suppl., 36(Oct. 1963).

3376 OPERATIONAL PROBLEMS OF THE GETR. Howard J. Larson and William N. Lorentz (General Electric Co., Pleasanton, Calif.). Trans. Am. Nucl. Soc., 6: Suppl., 38-9(Oct. 1963).

3377 DEFORMATION OF THE FORD NUCLEAR REACTOR SHIM-SAFETY RODS. J. B. Bullock (Univ. of Michigan, Ann Arbor). Trans. Am. Nucl. Soc., 6: Suppl., 40(Oct. 1963).

3378 BROKEN BLOCKS IN THE BROOKHAVEN GRAPHITE RESEARCH REACTOR: A GRAPHITE-GROWTH PROBLEM. Dudley Thompson (Brookhaven National Lab., Upton, N. Y.). Trans. Am. Nucl. Soc., 6: Suppl., 40-1(Oct. 1963).

3379 BERYLLIUM DAMAGE IN THE MATERIALS TESTING REACTOR—EXPERIMENTAL AND ANALYTICAL INVESTIGATIONS. V. A. Walker, J. W. Dykes, and A. D. Kartchner (Phillips Petroleum Co., Idaho Falls, Idaho). Trans. Am. Nucl. Soc., 6: Suppl., 42(Oct. 1963).

3380 WATER CHEMISTRY IN THE CANADA INDIA REACTOR. V. Surya Rao, S. M. Sundaram, and D. G. Vartak (Atomic Energy Establishment, Trombay, India). Trans. Am. Nucl. Soc., 6: Suppl., 44-5(Oct. 1963).

3381 THE BEHAVIOR OF URANIUM AND ALUMINUM IN THE NRU HEAVY-WATER SYSTEM. H. K. Rae (Atomic Energy of Canada Ltd., Chalk River, Ont.). Trans. Am. Nucl. Soc., 6: Suppl., 45(Oct. 1963).

3382 MONITORING AND DETECTION OF FISSION-PRODUCT RELEASE AT A 5MW RESEARCH REACTOR. Kenneth W. Skrable (Rutgers Univ., New Brunswick, N. J.). Trans. Am. Nucl. Soc., 6: Suppl., 48(Oct. 1963).

3383 FUEL-FAILURE DETECTION IN THE HWCTR. E. O. Kiger (E. I. duPont de Nemours & Co., Aiken, S. C.). Trans. Am. Nucl. Soc., 6: Suppl., 48-9(Oct. 1963).

3384 SOME PROBLEMS OF NUCLEAR RADIATION DETECTION IN LIGHT-WATER RESEARCH REACTORS. D. P. Roux (Oak Ridge National Lab., Tenn.). Trans. Am. Nucl. Soc., 6: Suppl., 51(Oct. 1963).

3385 EDUCATIONAL NUCLEAR REACTOR. Mark Muir Mills. U. S. Patent 3,110,656. Nov. 12, 1963. Filed Feb. 11, 1959.

An educational reactor is described for making visible flux densities of the radiations produced in the nuclear reaction. The reactor comprises the fuel, moderator, and reflector in the form of solutions enclosed in concentric cells which are either constructed entirely of glass or has observation ports. Small amounts of luminescent materials are added to one or more of the solutions and preferably are chosen to emit light of different colors. (D.L.C.)

WASTE DISPOSAL AND PROCESSING

Refer also to abstract 1797.

3386 (HW-68788) INCINERATOR AND OFF-GAS SCRUBBER TESTS. George Rey (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Mar. 9, 1961. Contract AT(45-1)-1350. 18p.

An experimental incinerator with an off-gas system consisting of a course fly ash remover, Peabody scrubber, and Absolute filter, was installed and tested in the 321 A Building. Typical "Z" plant combustible wastes (a mixture of rags, paper, wood and plastics, thoroughly shredded) were burned during the tests. Test conditions, coupled with a minimum equipment system, constituted a severe test of the incineration process. The process under the tested conditions has two major problem areas – (1) frequent filter pluggage with incinerator "soot" and (2) poor absorption of acidic vapors. If the recommendations can be feasibly incorporated into the existing "Z" plant design and operation these problems can be lessened, but would still predominate. Assuming optimum conditions, filter replacements can be expected on a weekly basis (8 hour day) and some five to ten percent of the nitric (HNO_3 + NO_2 mixture) vapors may not be absorbed. Greater than 99 percent of the acid vapors of chloride (possibly sulfates also) can be removed with the scrubber-filter combination. The estimate of weekly filter changes assumes the use of a secondary combustion chamber in the incinerator. To further delay filter pluggage a tertiary combustion may be required, or an exceptionally efficient secondary combustion, after which filter pluggage rates would be controlled by scrub liquor entrainment (40 lbs liquor 10^6 lbx off-gas). Use of in-place filter cleaning techniques would delay filter changes to one per month or two. An overall plutonium dust decontamination factor of 10^7 should be readily attained from incinerator to filter exhaust, with 99.9 percent remaining within the incinerator, mostly in the ash itself. (auth)

3387 (HW-76449) ION EXCHANGE SEPARATION OF CESIUM FROM ALKALINE WASTE SUPERNATANT SOLUTIONS. J. L. Nelson and B. W. Mercer (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Jan. 30, 1963. Contract AT(45-1)-1350. 31p.

Cesium separation from Purex alkaline supernatant waste by ion exchange with inorganic zeolites or phenolic resins was investigated. High cesium loadings were obtained with AW-400, a synthetic zeolite manufactured by the Linde Company. A disadvantage of the AW-400 is the poor quality of the binder; efforts are being made to obtain a more suitable binder. Optimum loading conditions appear to be a flow rate of one to two column volumes of actual waste per hour, with 20-50 mesh exchanger at a temperature of 25°C. A scrub or sodium removal step can be accomplished with several solutions; dilute ammonium carbonate solutions are preferred for aged alkaline supernatant wastes. Cesium is eluted with a solution of ammonium carbonate and ammonium hydroxide. Exchangers that are most selective for cesium and have the highest loadings also require the greatest elution volumes. Ammonium carbonate can be volatilized by heating, leaving a cesium solution that is very satisfactory for subsequent packaging operations. Under practical conditions a Cs/Na DF of 10^3 and cesium recovery of >99% can be obtained. (auth)

3388 (HW-77609(Sect.4)) CHEMICAL EFFLUENTS TECHNOLOGY. (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). 60p.

A group of several zeolites was examined for the ability to remove small amounts of Sr or Cs selectively from aquous wastes containing high concentrations of Na salts. Methods for the study of soil permeability are discussed. The use of electrical analog simulation to quantitatively analyze large, complex, saturated ground water flow systems is described. The use of scintillation and temperature probes in geophysical investigations and measurements of ground water flow is discussed. The removal of I^{131} from process gaseous exhaust streams, the hazards of accidentally heating recovered Cs^{137}, and fission product release from heated uranium are discussed. (C.H.)

3389 (IDO-14617) A METHOD OF DETERMINING VOLUMES AND SURFACE AREAS FOR GROUPS OF NON-UNIFORM SIZED PARTICLES. Earl S. Grimmett (Phillips Petroluum Co. Atomic Energy Div., Idaho Falls, Idaho). Oct. 1963. Contract (AT(10-1)-205. 32p.

A method for calculating the surface area and volume of samples of particles of various sizes and shapes is outlined. This method depends upon a screen analysis of the sample, size and surface interval functions, and screen shape factors. The size and surface interval functions can be calculated; screen shape factors can be estimated for other geometrically shaped particles, but must be determined experimentally for irregularly shaped particles. (auth)

3390 (IDO-16925(p.119-29)) WASTE MANAGEMENT AT THE NATIONAL REACTOR TESTING STATION. Denzel K. Jenson (Phillips Petroleum Co. Atomic Energy Div., Idaho Falls, Idaho and Idaho Operations Office, AEC).

Waste management at the National Reactor Testing Station (NRTS) is carried out to prevent harm of any type from coming to any person from the wastes generated by activities at the NRTS. High-level liquid waste, waste calcining facilities, solid waste, gaseous waste, and low-level liquid waste are discussed. Both concentration and confinement and dilution and dispersion are used in waste management. (M.C.G.)

3391 AN ANION EXCHANGE PROCESS FOR AMERICIUM–CURIUM RECOVERY FROM PLUTONIUM PROCESS WASTE. M. H. Lloyd (Oak Ridge National Lab., Tenn.). Nucl. Sci. Eng., 17: 452-6(Nov. 1963).

An anion exchange process for the recovery of americium, curium, and rare earths contained in the waste effluent from plutonium processing was developed and tested on a laboratory scale. In the process the waste, which is a solution of americium, curium, aluminum, and fission products, in concentrated nitric acid, is concentrated by evaporation until a temperature of 140°C is reached. This removes excess acid, and the proper feed concentration of 2.34 M $Al(NO_3)_3$ is obtained by dilution. The americium, curium, and rare earths are sorbed on Dowex 1–10X resin; aluminum is washed from the column with 8 M $LiNO_3$; and the americium, curium, and rare earths are eluted with 0.65 M HNO_3. In laboratory demonstrations of the process made with americium tracer and macro amounts of rare earths, americium losses were undetectable, aluminum decontamination factors were 250, and rare earth concentration in the product was as great as 8.5 gm/liter. (auth)

3392 A COMPARISON OF VARIOUS CALCINATION PROCESSES FOR HIGH-LEVEL RADIOACTIVE WASTES. B. R. Wheeler, J. A. Buckham, and J. A. McBride (Phillips Petroleum Co., Idaho Falls, Idaho). Trans. Am. Nucl. Soc., 6: 409-10(Nov. 1963).

3393 RADIOACTIVE WASTE DISPOSAL. Marshall L. Spector (to M. W. Kellogg Co.). U. S. Patent 3,110,557. Nov. 12, 1963. Filed Sept. 10, 1959.

A process is described for the incorporation of radioactive wastes containing metal oxides in a water-unleachable solid. In the process, the waste is reacted, in the presence of a solid metal oxide, with a base metal which has a higher exothermic heat of oxide formation per oxygen atom than that of the metal oxide. The reaction is initiated by heating the mixture, and the waste, metal oxide, and elemental metal form a solid complex mass which is insoluble and unleachable. The waste may contain Cs and/or Sr, while the metal oxide may be an oxide of Mg, Fe, or an oxide mixture found in haematite, magnetite, and ilmenite. The elemental metal may be Al, Si, Zr, or Mg. (D.L.C.)

GENERAL AND MISCELLANEOUS

3394 (BNL-6877) RADIATION RESISTANCE TESTS. Donald J. Metz (Brookhaven National Lab., Upton, N. Y.). Mar. 18, 1963. Contract AT-30-2-GEN-16. 84p.

The complex response of polymers to radiation necessitates knowledge of the radiation resistance and of the effects of radiation type, energy, and intensity on the resistance. A brief discussion is given of the types of radiation and their interactions with materials, and the techniques for measuring the amount of energy absorbed in a material from the radiation field are surveyed. Present-day knowledge of how various parameters and properties of the specimen affect its response to radiation is discussed. Some of the problems peculiar to exposing a sample to radiation are described. Finally, a survey is presented of the status of standard test methods for irradiated polymers. (D.L.C.)

3395 (BNL-6886) AN ANALYSIS OF H^3-THYMIDINE DISTRIBUTION THROUGHOUT THE SHOOT APICAL MERISTEM OF ARABIDOPSIS THALIANA (L.) HEYNH. J. A. M. Brown, J. P. Miksche, and H. H. Smith (Brookhaven National Lab., Upton, N. Y.). [1962]. Contract AT(30-2)-Gen-16. 15p.

Sequential autoradiographed sections through the shoot apical meristem of Arabidopsis thaliana treated for six hours with a solution of H^3-thymidine in combination with 0.1% Tween 20 and dilute mineral solution reveal a differential pattern of labeling, indicative of differential rates of DNA synthesis. This pattern corresponds to the histological zonation of the apex and reveals a sub-apical block of cells in which the amount of incorporation is significantly lower than in the adjacent flank cells. (auth)

3396 (BNL-6895) MICROSPOROGENESIS AND EMBRYOGENESIS IN QUERCUS. G. R. Stairs (Yale Univ., New Haven. School of Forestry and Brookhaven National Lab., Upton, N. Y.). [1962]. Contract AT(30-1)-2755. 21p.

Representative species from two subgenera in the genus Quercus were examined for floral structure and phenology, microsporogenesis, and embryogenesis. The species selected for investigation were: Quercus alba in the Lepidobalanus subgenera, and Quercus coccinea and Quercus ilicifolia from the Erythrobalanus group. Photographs of flowering and photomicrographs of microsporogenesis and embryogenesis are used for illustration. The male flowers of the three species are borne on catkins which develop in the scale leaf axils of the current vegetative bud or in separate male buds. Meiosis occurred in the spring at the beginning of bud enlargement; division figures were regular in all the material observed. A haploid chromosome number of 12 was confirmed for the three species. Pollen was shed on May 10, 1962, from trees of Quercus coccinea and Quercus ilicifolia; and on May 26, 1962 from Quercus alba. The female flowers are located in the axils of the new leaves. Seed development requires one growing season in Quercus alba, but two growing seasons are required to mature seed of Quercus coccinea and Quercus ilicifolia. The chronology of embryo development was similar for Quercus coccinea and Quercus ilicifolia; embryo development of Quercus alba was about two weeks behind that of the other two species. Definition of ovule dominance within a seed occurred at the time of early embryo development. Failure of this physiological expression of dominance results in multiseeded acorns. No abnormal embryogenesis per se was observed in relation to multiple embryo development. (auth)

3397 (HW-68600-32) PLUTONIUM ABSTRACTS. Volume 3, Number 10. (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Nov. 1, 1963. 19p.

A total of 38 references, most in abstracted form, is presented on the following subject fields: biology and medicine, chemistry, health and safety, metallurgy and ceramics, physics, and reactor technology. (D.L.C.)

3398 (HW-SA-2940) SYNTHESIS OF A CLINOPTILOLITE-LIKE ZEOLITE. L. L. Ames, Jr. (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Mar. 4, 1963. Contract AT(45-1)-1350. 14p.

Hydrothermal experiments were run on the systems $SiO_2-Al_2O_3-Li_2O-H_2O$, $SiO_2-Al_2O_3-Na_2O-H_2O$, $SiO_2-Al_2O_3-Na_2O-Li_2O-H_2O$, and $SiO_2-Al_2O_3-K_2O-H_2O$. A clinoptilolite-like phase was formed in the $SiO_2-Al_2O_3-Li_2O-H_2O$ system, but not in any of the other systems, although the products included mordenite, analcime, quartz, and chabazite. X-ray diffraction patterns and heat- and acid-treatments confirmed that the clinoptilolite-like phase was indeed a clinoptilolite. (D.L.C.)

3399 (IDO-16925) PRESENTATIONS OF 1963 AEC-CONTRACTORS NUCLEAR MATERIALS MANAGEMENT MEETING, [HELD AT] IDAHO FALLS, IDAHO, OCTOBER 16-18, 1963. (Phillips Petroleum Co. Atomic Energy Div., Idaho Falls, Idaho and Idaho Operations Office, AEC). Oct. 10, 1963. Contract [AT(10-1)-205]. 180p.

Fifteen papers presented at the Ninth Annual AEC and Contractor Nuclear Materials Management Meeting are given. Separate abstracts were prepared for eleven papers. Four papers were previously abstracted for NSA. (M.C.G.)

For abstracts of individual papers see: 1787, 1788, 1789, 1949, 1950, 1951, 2145, 2146, 3099, 3135, and 3390.

3400 (IS-700) ANNUAL SUMMARY RESEARCH REPORT OF CHEMISTRY, ENGINEERING, METALLURGY, PHYSICS AND REACTOR DIVISIONS, JULY 1, 1962–JUNE 30, 1963. General, Miscellaneous, and Progress Reports. (Ames Lab., Ames, Iowa). Sept. 1963. Contract W-7405-eng-82. 452p.

Research and development progress is reported on chemistry, engineering, metallurgy, physics, and reactors. Separate abstracts were prepared for each of the five topics. (M.C.G.)

For abstracts of individual sections see: 1483, 1834, 2163, 2401, and 3320.

3401 (IS-721) ADDSTORAGE FORTRAN FOR THE IBM 7074/2/4. D. R. Fitzwater, E. H. Hietbrink, and D. E. McFarland (Ames Lab., Ames, Iowa). Sept. 1963. Contract W-7405-eng-82. 28p.

The modifications of the IBM 7070 Series Compiler System to compile FORTRAN programs to be run in the additional storage made are described. Maintenance of the system, changes for machines of other sizes, and modifications to the FORTRAN LOADER, PACKAGE, and LIBRARY are also considered. (D.C.W.)

3402 (LADC-5688) NON-LINEAR TRANSFORMATION STUDIES ON ELECTRONIC COMPUTERS. P. R. Stein and S. M. Ulam (Los Alamos Scientific Lab., N. Mex.). [1962]. Contract W-7405-eng-36. 129p.

The properties of certain non-linear transformations in Euclidean spaces—mainly in two or three dimensions—are examined. The transformations, generally of very special and simple algebraic form, are bounded and continuous, but in general many-to-one. The iteration of the transformations and the asymptotic and ergodic properties of the sequence of iterated points are of primary interest; but the invariant points, finite sets, and invariant subsets of the transformations and the means for obtaining them constructively are also considered. (D.C.W.)

3403 (LADC-5694) THE STATUS OF FLAT ROLLING THEORY. John E. Hockett (Los Alamos Scientific Lab., N. Mex.). [1962]. Contract W-7405-eng-36. 26p.

A few of the most important rolling theories are discussed and the objections to them delineated. The assumptions involved in the theories are mentioned. The difficulty of treating lateral spread (finite strains in three dimensions) is considered. In any theory, the stress-strain properties of the metal to be rolled and the coefficient of friction in the roll gap must be known in detail for a variety of conditions. The possibility of a general or universal theory of rolling in the future is discussed. (D.L.C.)

3404 (LADC-5731) RESIDUAL TEMPERATURES OF SHOCKED COPPER. John W. Taylor (Los Alamos Scientific Lab., N. Mex.). [1960]. Contract W-7405-eng-36. 19p.

A photoelectric technique is described for measuring the residual temperature of strongly shocked metals. Data for copper shocked to pressures ranging from 0.9 to 1.7 megabars are in good agreement with published calculations of temperatures. (auth)

3405 (NP-13282) COMMISSARIAT A L'ENERGIE ATOMIQUE. (Annual Report of Commissariat a l'Energie Atomique, 1962). (France. Commissariat à l'Énergie Atomique, Paris). 1962. 192p.

The annual report of the CEA gives a survey of its activities with only an indication of the results of particular studies. The general structure and finances of the CEA are given. The activities summarized are the production of basic materials of nuclear industry, technological and scientific investigation (general physics, reactor physics, fuel element studies, nuclear materials, chemistry, biology, health physics, radiation protection, and mineralogy), reactors, artificial radioisotopes, military applications, relations of the CEA with industry, international and public relations, and teaching and training. The organization and composition of committees and consultative commissions are given. (J.S.R.)

3406 (NYO-8104) HORIZONTAL DIFFUSION FROM AN INSTANTANEOUS POINT-SOURCE DUE TO OCEANIC TURBULENCE. Technical Report No. 32. Akira Okubo (Johns Hopkins Univ., Baltimore. Chesapeake Bay Inst.). Dec. 1962. Contract AT(30-1)-1477. 124p.

A discussion is presented of horizontal turbulent diffusion of a patch of a diffusive substance released from an instantaneous point-source in the sea—a situation to which a knowledge of the similarity theory of turbulence may be applied to some extent. A systematic derivation of some proposed concentration distributions for a patch is developed on the basis of a non-Markov hypothesis combined with knowledge of the rate of mean square dispersion. A new proposal for the concentration distribution is also presented. The solutions of Joseph and Sendner, Ozmidov, Obukhov, Schönfeld, Okubo and Pritchard, and Okubo are critically discussed in comparison with available information about horizontal diffusion in the sea. A re-examination is made of the relations between the variance of the distribution and diffusion time, and between the coefficient of eddy diffusion and the scale of the phenomenon, using accumulated data. In addition to this, some speculation about the two-dimensional horizontal energy spectrum of oceanic turbulence is presented. (auth)

3407 (NYO-10710) FACTORS INFLUENCING THE METABOLISM OF COPPER AND IRON. Final Report, June 1, 1962–September 14, 1963. (Johns Hopkins Univ., Baltimore). Oct. 1, 1963. Contract AT(30-1)-1816. 31p.

Progress is reported in a study of the interrelationships among Cu, Mo, and S in the nutrition and metabolism of rats and bacteria. Data are presented on the role of sulfide oxidase in Cu-deficiency associated with Mo toxicity in rats and the avoidance of Mo-containing diets by rats. A detailed study of inorganic S metabolism in Escherichia coli and Salmonella typhimurium revealed new information concerning the sequence of reactions in organic S metabolism, the genetic regulation of these metabolic pathways, and enzyme control of repression and feedback inhibition. A list is included of publications during the period covered by this report. (C.H.)

3408 (SC-4964(RR)) THE UNIT CELL OF HODGKINSONITE. Edward J. Graeber (Sandia Corp., Albuquerque, N. Mex.) and Abraham Rosenzweig (New Mexico. Univ., Albuquerque). Nov. 1963. Contract AT(29-1)-789. 7p.

The mineral hodgkinsonite, $Mn(ZnOH)_2SiO_4$, crystallizes in space group $P2_1/c(C_{2h}^5)$. There are four molecules in the monoclinic cell of dimensions $a_0 = 11.764$Å, $b_0 = 5.218$Å, $c_0 = 8.182$Å, and $\beta = 95°25'$. (auth)

3409 (SC-DR-168-63) SEQUENTIAL TIMER. E. O. Williams (Sandia Corp. Livermore Lab., Livermore, Calif.). Nov. 1963. Contract [AT(29-1)-789]. 10p.

The sequential timer, or "10-digit clock," provides timing signals for use in recording the time of occurrence of events during the flight of a test vehicle. The timer uses a binary counting system and a recording matrix to retain timing data initiated by firing and fuzing components. (auth)

3410 (SC-TM-83-62(71)) THE DEVELOPMENT OF A STATIC PRESSURE PROBE FOR THE INTERACTION REGION OF SHOCK WAVES AND BOUNDARY LAYERS. John Earle Rode and Victor J. Skogland (Sandia Corp., Albuquerque, N. Mex.). Apr. 1962. Contract AT(29-1)-789. 115p.

A cylindrical static pressure probe with an outside diameter of 0.016 inch and port diameters of 0.004 inch was developed for measuring static pressures in the interaction region of an oblique shockwave and a turbulent boundary layer at a free stream Mach number of 2.5. Several probe configurations with and without boundary layer trips were calibrated in the boundary layer where the Mach number is variable and in a shock wave where the pressure gradients are much higher than in the interaction region of interest. The best configuration consisted of a 14-degree included angle, cone cylinder with the two ports located 12 tube diameters from the upstream tip. This probe was calibrated in yaw and pitch, and it was used in a preliminary survey of the static pressures in the interaction region of a shock wave with a 30-degree wave angle and a turbulent boundary layer with a thick-

ness of 0.085 inch. The results showed that the pressure gradient normal to the wall in an interaction region is appreciable. (auth)

3411 (TID-18367) ON THE THEORY OF CONDUCTIVE HEAT TRANSFER IN FINITE REGIONS. [PART] I. Nurettin Y. Oelcer (Argonne National Lab.,.Ill.). Jan. 1963. Contract W-31-109-eng-38. 12p. (UAC-7219)

Finite integral transform techniques are applied to the solution of three-dimensional, transient heat-conduction problems with general, time-dependent heat sources and boundary conditions. The latter include, as special cases, the boundary conditions of the first, second, and third kinds (prescribed temperature, prescribed flux, and Newtonian convection conditions) or any combination of these three, which are often encountered in engineering problems. From the series solution obtained, an alternate form is derived which consists of quasi-steady and transient terms. This constitutes a generalization of a recent paper in which the bulk and surface source functions were assumed to be separable in the space and time variables. (auth)

3412 (TID-18403) FIXED LENGTH CONFIDENCE INTERVALS VIA TWO-STAGE PROCEDURES. Judah Rosenblatt (Sandia Corp., Albuquerque, N. Mex.). Mar. 1963. Contract AT(29-1)-789. 9p. (SCDC-3129)

It is shown that solution of certain interval estimation problems by two-stage procedures requires more than one observation in the first stage. The basic theorem for constructing such multi-observational two-stage schemes is proved along with two corollaries. (D.C.W.)

3413 (TID-19686) FLIPFLOP STABILITY TEST REPORT — THREE-FLIPFLOP MODEL. Dennis Hall (Illinois. Univ., Urbana. Digital Computer Lab.). Jan. 30, 1963. Contract [AT(11-1)-1018]. 8p.

The stability of the three-flipflop model of the bubbling register in the stacking operation with a 1-Mc drive pulse train was tested. The results indicate stable operation of the model for pulse frequencies of about 1 Mc. (D.C.W.)

3414 (TID-19687) SPECIFICATIONS FOR THIN FILM, PASSIVE ELEMENT MICROCIRCUIT MODULES. Bruce H. McCormick (Illinois. Univ., Urbana. Digital Computer Lab.). July 31, 1963. Contract AT(11-1)-1018. 22p.

Specifications for the design, fabrication, and delivery of modules to be used in an all-digital pattern recognition computer are given. Acceptance test standards are also included. (D.C.W.)

3415 (TID-19694) THE TRANSFER MEMORY. Report No. 145. S. R. Ray (Illinois. Univ., Urbana. Digital Computer Lab.). Aug. 16, 1963. Contract AT(11-1)-1018. 31p.

The specialized memory unit that mediates information flow from the primary processing logic to the control and bulk storage areas in the ILLIAC III is described. Magnetic cores are used as the basic storage elements of the memory. The Pyramidal Readout Encoder, which provides content addressibility to the memory, is also described. (D.C.W.)

3416 (TID-19697) SPECIFICATION FOR NPN PLANAR, PASSIVATED, EPITAXIAL, SILICON, SWITCH ING TRANSISTORS. K. C. Smith (Illinois. Univ., Urbana Digital Computer Lab.). May 16, 1963. Contract [AT(11-1)-1018]. 3p.

The total dissipation (0.3w), electrical characteristics, and turn-off times required at 25°C ambient are listed. (D.C.W.)

3417 (TID-19698) SPECIFICATIONS FOR MINIATURE DIFFUSED PASSIVATED SILICON MESA SWITCHING DIODES. K. C. Smith (Illinois. Univ., Urbana. Digital Computer Lab.). May 20, 1963. Contract [AT(11-1)-1018]. 2p.

The glass package dimensions, electrical characteristics (at 25°C), and recovery times specified are given. (D.C.W.)

3418 (TID-19699) SPECIFICATIONS FOR MINIATURE PLANAR PASSIVATED, EPITAXIAL, SILICON, SWITCHING DIODE. K. C. Smith (Illinois. Univ., Urbana. Digital Computer Lab.). June 14, 1963. Contract [AT(11-1)-1018]. 2p.

The size, electrical characteristics, and recovery times that the diodes must possess at 25°C are listed. (D.C.W.)

3419 (TID-19700) USER'S MANUAL FOR PAX. AN IBM 7090 PROGRAM TO SIMULATE THE PATTERN ARTICULATION UNIT OF ILLIAC III. Report No. 147. James H. Stein (Illinois. Univ., Urbana. Digital Computer Lab.). July 29, 1963. Contract AT(11-1)-1018. 34p.

The general structure of PAX and the details prerequisite to use of the simulator are described. The simulated machine, input, output, time considerations, plane memory, and instructions and their manipulation are covered. (D.C.W.)

3420 (TID-19701) LABPAX, A VERSION OF PAX INTENDED FOR USE WITHIN THIS LABORATORY. James H. Stein (Illinois. Univ., Urbana. Digital Computer Lab.). Sept. 9, 1963. Contract AT(11-1)-1018. 4p.

The program LABPAX, an assembly-language version of PAX that can be incorporated with a master program on a single machine run to simulate PAU programs, is described. (D.C.W.)

3421 (TID-19702) PROGRAM DESCRIPTION OF PAX. AN IBM 7090 PROGRAM TO SIMULATE THE PATTERN ARTICULATION UNIT OF ILLIAC III. Report No. 151. James H. Stein (Illinois. Univ., Urbana. Digital Computer Lab.). Sept. 16, 1963. Contract AT(11-1)-1018. 49p.

The subroutines, their parameter blocks, transfer of control among them, and instructions are discussed. Parameter block formats and the program listing are included. Extension of the program is also considered. (D.C.W.)

3422 (TID-19703) DATA ON CABLE DRIVERS AND TERMINATORS FOR ILLIAC III. S. Yamada and D. Foster (Illinois. Univ., Urbana. Digital Computer Lab.). Aug. 28, 1963. Contract AT(11-1)-1018. 8p.

Data on the speed and operating limits of the drivers and terminators, noise and reflection on cables, delay times, and tolerances are included. (D.C.W.)

3423 (TID-19704) TRANSISTOR SPECIFICATION FOR FAST LOGIC CIRCUITS OF ILLIAC III: NPN DIFFUSED SILICON PLANAR EXITAXIAL TRANSISTOR. S. Yamada (Illinois. Univ., Urbana. Digital Computer Lab.). May 31, 1963. Contract AT(11-1)-1018. 13p.

The electrical properties required of the transistors are listed, and the criterion developed to estimate the value of a transistor in the circuits is presented and demonstrated. (D.C.W.)

3424 (TID-19705) TABLE OF MEASURED TRANSISTOR PARAMETERS FOR CURRENTLY AVAILABLE SILICON NPN TRANSISTORS. Shigeharu Yamada and Hans Bilger (Illinois. Univ., Urbana. Digital Computer Lab.). June 5, 1963. Contract AT(11-1)-1018. 5p.

Correlation and transient data and various electrical parameters are tabulated for ten transistors. (D.C.W.)

3425 (TID-19712) CABLE DRIVER AND TERMINATOR DESIGN. Report No. 146. Shigeharu Yamada (Illinois. Univ., Urbana. Digital Computer Lab.). Aug. 21, 1963. Contract AT(11-1)-1018. 20p.

A theoretical treatment of a design of very general applicability is presented. (auth)

3426 (TID-19715) PERFORMANCE CHARACTERISTICS OF FAST LOGIC FOR ILLIAC III: BASIC NAND AND NOR CIRCUITS. Report No. 152. Shigeharu Yamada (Illinois. Univ., Urbana. Digital Computer Lab.). Sept. 18, 1963. Contract AT(11-1)-1018. 34p.

The characteristics of the basic logic circuits are given with test data taken from prototype printed-circuit boards. Design and operating speed considerations are also presented. (auth)

3427 (TID-19716) PRELIMINARY DISCUSSION OF LIST PROCESSOR DESIGN. Kimio Ibuki (Illinois. Univ., Urbana. Digital Computer Lab.). Aug. 15, 1963. Contract AT(11-1)-1018. 31p.

List and bilateral processing are required in the anticipated data processing of ILLIAC III. The Taxicrinic Unit in which list and graph structures can be directly processed by instructions at the machine level is introduced. List and graph structure representation, list structure storage, a syntax for a list structure, scanning modes, memory, and data sequence control are discussed. (D.C.W.)

3428 (TID-19732) POLAROGRAPHIC CELL FOR THE CONTINUOUS ANALYSIS OF FLOWING SOLUTIONS. W. J. Blaedel and J. H. Strohl (Wisconsin. Univ., Madison). [1962]. Contract AT(11-1)-1082. 9p.

A simple Teflon-glass polarographic cell was designed to have a small holdup volume. The construction of the cell is described. The response of the cell to a change from a NaCl solution to a NaCl–$CdCl_2$ solution is described. The variation of diffusion current with flow rate is also shown. (D.L.C.)

3429 (TID-19733) THE DYNAMICS OF THE PRESSURE BUILDUP IN THE DRY WELL. Bimonthly Report. Norman H. Ceaglske (Minnesota. Univ., Minneapolis). Oct. 15, 1963. Contract [AT(11-1)-926]. 24p.

The feasibility of using linearized equations to represent the pressure rise in the dry well is evaluated. The linearized equations for the dead-end operation check the experimental data over the range where the inflow is constant. The difference that does occur is due to the high pressure in the pipe ahead of the solenoid valve. When the tank is connected to the tubes immersed in water the results calculated from the equations again checks the experimental results reasonably well. (N.W.R.)

3430 (TID-19737) STABILITY AND VAPORIZATION BEHAVIOR OF GROUP IV-VI TRANSITION METAL MONOPHOSPHIDES. K. A. Gingerich (Pennsylvania State Univ., University Park). [1962]. Contract AT(30-1)-2541. 5p.

The vaporization properties of the monophosphides of Ti, Zr, Hf, Nb, Ta, Mo, and W were studied using a Knudsen effusion-mass spectrometer assembly. The primary phosphorus species observed in the vapor were P, P_2, and P_4, with P_2 being the major species at 1000 to 1800°K and P being important at higher temperatures. P_4 was either a minor species or not detectable under all conditions. No gaseous species containing both metal and phosphorus was detected. Partial molal free enthalpies of P_2 dissociation were calculated for Ti, Zr, Nb, Mo, and W phosphides. The stability of the phosphides is compared with that of the corresponding nitrides. (D.L.C.)

3431 (TID-19739) DENSITIES AND LATTICE PARAMETERS OF TIN (INDIUM) SOLID SOLUTIONS. W. J. Helfrich and R. A. Dodd (Wisconsin. Univ., Madison). [1963]. Contract [AT(11-1)-987]. 9p.

Observed densities, x-ray (theoretical) densities, and lattice parameters were measured for Sn–In solid solutions over the range of 0 to 5 at. % In, particularly in the region of 1.8 to 2.0 at. % In. The results are plotted as a function of composition. Both observed density and lattice parameters were found to vary exactly linearly with composition, and observed and theoretical densities are in exact agreement, in contradiction to the data of Lee and Raynor, which show minimia at ~1.9 at. % In. It is concluded that the low results of Lee and Raynor were due to solidification microporosity, and that no metallic primary solid solution has been shown to contain high vacancy concentrations due to Brillouin zone effects. (D.L.C.)

3432 (UCRL-10455) ENERGETICS IN DISLOCATION MECHANICS. John E. Dorn (California. Univ., Berkeley. Lawrence Radiation Lab.). Feb. 1963. Contract W-7405-eng-48. 197p.

Theory on the nature and structure of dislocations; the dynamic behavior of dislocations, particularly thermally activated dislocation motion; and solute atom strengthening is reviewed. 72 references. (D.C.W.)

3433 (AEC-tr-6130) INSTANTANEOUS OBSERVATION OF SPECTRAL EXCITATION PROCESSES IN A SPARK. Shao-min Wang. Translated from Wu Li Hsueh Pao, 18: 594-9(1962). 11p.

The time resolution process of excitation intensity of spectral lines in a spark light source is measured. In a spark, operating under a state of critical damping with a flash time at 2×10^{-6} sec., ion lines with high excitation potential appear first, but for a short moment. Experiments show that, as to time, two spectral lines AlI and MoII, which pile up at 3961.5 Å, can be entirely separated, thus providing the possibility of avoiding interference and using the sensitive lines for spectrum analysis. (auth)

3434 (UCRL-Trans-994(L)) FREQUENCY DISPLACEMENTS IN THE SYSTEM WATER/p-DIOXANE. Hartmut Fritzsche. Translated by Virginia F. Simson (California. Univ., Livermore. Lawrence Radiation Lab.), from Spectrochim. Acta, 17: 352-5(1961). 7p.

Measurements were taken of frequency shifts occurring in the infra-red bands of p-dioxane when water is added. The recorded amounts and signs rendered possible the derivation of an interaction mechanism which except for the formation of hydrogen bondings is based on dipole induction as a cause for the measured frequency shifts. (auth)

3435 (UCRL-Trans-997(L)) EFFECT OF HIGH PRESSURE ON THERMAL PROPERTIES OF A SOLID BODY. K. P. Rodionov. Translated by Sergey Shewchuck (Univ. of California Lawrence Radiation Lab., Livermore). from Fiz. Metal. i Metalloved., 3: 26-30(1956). 10p.

The effects of high pressure on the thermal expansion and thermal capacity of a solid body involve first a decrease and then an increase. At attempt is made to interpret the effects in a theoretical manner. Two equations are derived for the pressure at which a minimum appears in the thermal expansion, and the calculated pressures are compared for a large number of metals. For the thermal capacity, a similar decrease-increase effect is also derived, but the increase is not so abrupt as for the expansion. A refutation is given to Bridgman's hypothesis that at pressures of the order of 10^9 kg/cm^2, the thermal capacity must approach zero. (D.L.C.)

3436 TRANSACTIONS OF THE AMERICAN NUCLEAR SOCIETY 1963 WINTER MEETING, NEW YORK CITY, NOVEMBER 18-21, 1963. Malcolm D. Ferrier, ed. Trans. Am. Nucl. Soc., 6: 209-474(Nov. 1963).

Summaries of 317 papers are included. The titles of 266 summaries are included in this issue of NSA. Complete text was available for 51 papers, and abstracts of these papers appeared in the Jan. 15 issue of NSA. (D.E.B.)

For titles of individual papers see: 1585, 1586, 1587, 1659, 1660, 1661, 1662, 1663, 1767, 1768, 1769, 1770, 1822, 1823, 1824, 1875, 1876, 1877, 1878, 1980, 2006, 2082, 2083, 2084, 2085, 2086, 2087, 2088, 2089, 2090, 2091, 2092, 2113, 2114, 2115, 2116, 2117, 2118, 2119, 2176, 2184, 2185, 2186, 2187, 2188, 2189, 2190, 2191, 2192, 2193, 2208, 2209, 2210, 2274, 2275, 2276, 2277, 2278, 2336, 2337, 2338, 2339, 2340, 2341, 2342, 2343, 2344, 2345, 2346, 2347, 2348, 2349, 2350, 2351, 2352, 2353, 2354, 2355, 2356, 2357, 2358, 2359, 2360, 2361, 2362, 2363, 2561, 2568, 2578, 2788, 2789, 2790, 2791, 2792, 2793, 2794, 2795, 2796, 2797, 2798, 2799, 2800, 2801, 2802, 2803, 2804, 2805, 2806, 2807, 2808, 2809, 2810, 2811, 2812, 2813, 2814, 2815, 2816, 2817, 2818, 2819, 2820, 2821, 2822, 2823, 2824, 2825, 2826, 2827, 2828, 2829, 2964, 2965, 2966, 2967, 2968, 2969, 2970, 2971, 2972, 3031, 3032, 3033, 3034, 3035, 3036, 3037, 3066, 3067, 3068, 3069, 3070, 3071, 3106, 3107, 3108, 3109, 3110, 3111, 3112, 3113, 3114, 3115, 3116, 3117, 3118, 3119, 3120, 3121, 3122, 3123, 3124, 3125, 3130, 3131, 3132, 3133, 3143, 3144, 3145, 3146, 3147, 3148, 3149, 3150, 3151, 3152, 3153, 3154, 3155, 3156, 3205, 3206, 3207, 3208, 3209, 3210, 3211, 3212, 3213, 3214, 3215, 3216, 3217, 3218, 3219, 3220, 3221, 3222, 3223, 3224, 3225, 3226, 3227, 3228, 3229, 3230, 3231, 3232, 3233, 3234, 3235, 3236, 3237, 3238, 3239, 3240, 3241, 3242, 3243, 3244, 3245, 3246, 3247, 3248, 3249, 3250, 3251, 3252, 3253, 3254, 3255, 3256, 3257, 3258, 3259, 3260, 3261, 3262, 3263, 3264, 3265, 3266, 3304, 3305, 3306, 3307, 3308, 3350, 3351, 3352, 3353, 3354, 3355, 3356, and 3392.

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ä	becomes	ae
ö		oe
ø		oe
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7391	18-1650	Phys. Rev. Letters, 11: 460-2(1963)
BNL-T-		
310	18-1941	See BNL-807
BPR-XIII-		
9&10-63	18-1868	See TID-19661
BSD-TDR-	**(Non-AEC)**	
63-196	18-2571	$1.60(OTS)
CAPE-		
662	18-2010	EM
1039	18-1852	EM
1040	18-1983	EM
1041	18-1854	EM
1044	18-1853	EM
1049	18-2096	EM
1054	18-1984	EM
CEA-	**(French)**	
2048	18-2976	Dep.(mc)
2231	18-1942	Dep.(mc)
2235	18-3312	Dep.(mc)
2237	18-1785	Dep.(mc)
2259	18-2583	Dep.(mc)
2276	18-1860	Dep.(mc)
2277	18-1943	Dep.(mc)
2280	18-2179	Dep.(mc)
2285	18-1496	Dep.(mc)
2293	18-3313	Dep.(mc)
2295	18-2195	Dep.(mc)
2307(Vol.1)	18-3314	
2307(Vol.2)	18-3315	Dep.(mc)
2307(Vol.3)	18-3316	Dep.(mc)
2311	18-1944	Dep.(mc)
2313	18-2495	Dep.(mc)
2315	18-1600	Dep.(mc)
2322	18-1786	Dep.(mc)
2323	18-1945	Dep.(mc)
2324	18-1497	Dep.(mc)
2326	18-1601	Dep.(mc)
2330	18-1910	Dep.(mc)
2338	18-2196	Dep.(mc)
2346	18-2779	Dep.(mc)
2352	18-1498	Dep.(mc)
CEA-tr-	**(French)**	
A-1378	18-1732	Dep.(mc); $4.60(fs), $1.67(mf) JCL
X-175	18-1803	Dep.(mc); $1.60(fs), $0.80(mf) JCL
X-487	18-2235	Dep.(mc); $1.60(fs), $0.80(mf) JCL
X-490	18-1378	Dep.(mc); $1.60(fs), $0.80(mf) JCL
X-494	18-1804	Dep.(mc)
X-517	18-2182	Dep.(mc); $5.60(fs), $1.94(mf) JCL
CERN-	**(European Organization for Nuclear Research)**	
63-30	18-2496	Dep.(mc)
CEX-		
61.6.3	18-1946	Dep.; $0.50(OTS)
CLM-	**(British)**	
P23	18-3021	Proc. Phys. Soc. (London), 82: 641-54 (1963)
CLM-R-	**(British)**	
29	18-2977	Dep.; $0.60(BIS); 3s. (HMSO)
CLOR-l-	**(Polish)**	
B-IBJ-18	18-2019	Dep.
CN-		
15/11	18-3287	See CONF-69-14
CNLM-	**(Misc.)**	
5202	18-3291	
CONF-1-	**(Institute of Electrical and Electronics Engineers 1963 Summer Meeting, Toronto, June 1963)**	
27	18-2382	ORINS. Gmelin, AED-CONF-63-073-71
CONF-24-	**(4th Symposium [on] Engineering Aspects of Magnetohydrodynamics, Berkeley, Calif., Apr. 1963)**	
19	18-2579	ORINS. Gmelin, AED-CONF-63-030-22
CONF-30-	**(American Physical Society 1962 Winter Meeting in the West, Stanford, Calif., Dec. 1962)**	
5	18-2963	ORINS. Gmelin, AED-CONF-62-257-41
CONF-39-	**(American Nuclear Society 9th Annual Meeting, Salt Lake City, June 1963)**	
102	18-2831	ORINS. Gmelin, AED-CONF-63-060-108
104	18-2780	Dep.(mc); $6.60(fs), $2.21(mf) OTS; Gmelin, AED-CONF-63-060-109
105	18-2216	Dep.(mc); $1.10(fs), $0.80(mf) OTS; Gmelin, AED-CONF-63-060-99
CONF-46-	**(American Physical Society 1963 Spring Meeting, Washington, D. C., Apr. 1963)**	
106	18-2098	ORINS. Gmelin, AED-CONF-63-048-115
108	18-2843	See TID-19193
109	18-2978	Dep.(mc); $2.60(fs), $0.89(mf) OTS; Gmelin, AED-CONF-63-048-112
CONF-67-	**(Health Physics Society 8th Annual Meeting, New York, New York, June 1963)**	
32	18-1986	ORINS. Gmelin, AED-CONF-63-049-35
33	18-1988	ORINS. Gmelin, AED-CONF-63-049-34
CONF-69-	**(Conference on Operating Experience with Power Reactors, Vienna, June 1963)**	
14	18-3287	ORINS.
CONF-73-	**(Sixth Biennial Conference on Carbon, Pittsburgh, June 1963)**	
16	18-1703	ORINS. Gmelin, AED-CONF-63-061-19
17	18-1702	ORINS. Gmelin, AED-CONF-63-061-26
20	18-2289	ORINS. Gmelin, AED-CONF-63-061-25
CONF-74-	**(11th Annual Conference on Mass Spectrometry and Allied Topics, San Francisco, May 1963)**	
22	18-1597	ORINS. Gmelin, AED-CONF-63-050-45
23	18-2492	ORINS. Gmelin, AED-CONF-63-050-44
CONF-78-	**(American Physical Society 1963 Summer Meeting, Buffalo, June 1963)**	
17	18-3025	ORINS. Gmelin, AED-CONF-63-090-28
18	18-3026	ORINS. Gmelin, AED-CONF-63-090-29
CONF-89-	**(International Symposium on Humidity and Moisture, Washington, D. C., May 1963)**	
6	18-2011	ORINS. Gmelin, AED-CONF-63-068-8
CONF-102-	**(American Society of Mechanical Engineers 1963 Winter Meeting, Philadelphia, Nov. 1963)**	
7	18-3083	New York, American Society of Mechanical

Report No.	Abstract No.	Availability
		Engineers, 1963, Preprint 63-WA-100, ORINS
8	18-2491	New York, American Society of Mechanical Engineers, 1963, Preprint 63-WA-56, ORINS
9	18-3310	New York, American Society of Mechanical Engineers, 1963, Preprint 63-WA-55, $1.00, ORINS
10	18-3082	New York, American Society of Mechanical Engineers, 1963, Preprint 63-WA-88, $1.00, ORINS
11	18-2490	New York, American Society of Mechanical Engineers, 1963, Preprint 63-WA-136, ORINS
12	18-1880	New York, American Society of Mechanical Engineers, 1963, Preprint 63-WA-51, ORINS
13	18-1881	New York, American Society of Mechanical Engineers, 1963, Preprint 63-WA-76, ORINS
14	18-1856	New York, American Society of Mechanical Engineers, 1963, Preprint 63-WA-54, $1.00, ORINS
15	18-2212	New York, American Society of Mechanical Engineers, 1963, Preprint 63-WA-53, $1.00, ORINS
16	18-1855	New York, American Society of Mechanical Engineers, 1963, Preprint 63-WA-92, $1.00, ORINS
CONF-117–		**(American Chemical Society 145th National Meeting, New York, Sept. 1963)**
7	18-1704	ORINS. Gmelin, AED-CONF-63-133-22
9	18-1861	Dep.(mc); $2.60(fs), $0.95(mf) OTS; Gmelin, AED-CONF-63-133-21
11	18-1602	Dep.(mc); $1.60(fs), $0.80(mf) OTS; Gmelin, AED-CONF-63-133-25
12	18-1619	See UCRL-10920
13	18-1782	ORINS. Gmelin, AED-CONF-63-133-30
14	18-1603	Dep.(mc); $1.10(fs), $0.80(mf) OTS; Gmelin, AED-CONF-63-133-9
15	18-1720	ORINS. Gmelin, AED-CONF-63-133-28
17a	18-1779	ORINS. Gmelin, AED-CONF-63-133-17
17b	18-1780	ORINS. Gmelin, AED-CONF-63-133-18
CONF-122–		**(International Conference on Nucleon Structure, Stanford, Calif., June 1963)**
16	18-2584	Dep.(mc); $1.10(fs), $0.80(mf) OTS; Gmelin, AED-CONF-63-101-17
CONF-126–		**(Conference on Noble Gas Compounds, Argonne, Ill., April 1963)**
19	18-1604	Dep.(mc); $1.60(fs), $0.80(mf) OTS; Gmelin, AED-CONF-63-085-19 p.167-73 of "Noble-Gas Compounds." Chicago, Univ. of Chicago Press, 1963
CONF-135–		**(International Symposium on High Temperature Technology, Asilomar, Calif., Sept. 1963)**
4	18-2286	ORINS. Gmelin, AED-CONF-63-135-3
5	18-1840	ORINS. Gmelin, AED-CONF-63-135-4
CONF-147–		**(Instrument Society of America Conference, Chicago, Sept. 1963)**
4	18-2014	Chicago, Instrument Society of America, 1963, Preprint 61.3.63, $1.00, ORINS
5	18-2124	Chicago, Instrument Society of America, 1963, Preprint 62.2.63, $1.00, ORINS
6	18-2013	Chicago, Instrument Society of America, 1963, Preprint 58.2.63, $1.00, ORINS
8	18-2012	Chicago, Instrument Society of America, 1963, Preprint 43.2.63, $1.00, ORINS
9	18-2122	Chicago, Instrument Society of America, 1963, Preprint 31.2.63, $1.00, ORINS
10	18-2123	Chicago, Instrument Society of America, 1963, Preprint 25.3.63, $1.00, ORINS
11	18-3126	Chicago, Instrument Society of America, 1963, Preprint 25.4.63, $1.00, ORINS
CONF-164–		**(Society of Nuclear Medicine 10th Annual Meeting, Montreal, June 1963)**
10	18-1480	ORINS. Gmelin, AED-CONF-63-100-15
CONF-166–		**(American Society for Testing Materials 66th Annual Meeting, Atlantic City, June 1963)**
11	18-2383	ORINS. Gmelin, AED-CONF-63-098-11
CONF-174–		**(12th Annual Conference on Application of X-ray Analysis, Denver, Aug. 1963)**
6	18-2097	ORINS. Gmelin, AED-CONF-63-123-17
7	18-1595	ORINS. Gmelin, AED-CONF-63-123-19
CONF-187–		**(American Nuclear Society Meeting, New York, Nov. 1963)**
12	18-3094	Dep.(mc); $1.10(fs), $0.80(mf) OTS
21	18-2781	See LADC-5904
CONF-191–		**(Society of Automotive Engineers National Aeronautic and Space Engineering and Manufacturing Meeting, Los Angeles, Sept. 1963)**
6	18-1857	New York, Society of Automotive Engineers, 1963, Preprint 727B, ORINS
CONF-204–		**(International Conference on Lattice Dynamics, Copenhagen, Denmark, Aug. 1963)**
4	18-2830	ORINS
CONF-205–		**(International Atomic Energy Agency Symposium on the Biological Effects of Neutron Irradiations, Upton, N. Y., Oct. 1963)**
5	18-1375	See BNL-7371
6	18-1374	See BNL-7367
7	18-1373	See BNL-7360
8	18-1372	See BNL-7359
9	18-1371	See BNL-7343
CONF-206–		**(Symposium on Carbides in Nuclear Energy, Harwell, Eng., Nov. 1963)**
3	18-2222	See LADC-5907
4	18-2223	See LADC-5924
CONF-209–		**(American Vacuum Society Meeting, Boston, Oct. 1963)**
3	18-1891	ORINS. Gmelin, AED-CONF-63-161-1
4	18-2777	ORINS. Gmelin, AED-CONF-63-161-11
5	18-1890	ORINS. Gmelin, AED-CONF-63-161-12
6	18-2499	See PPAD-498E
12	18-2177	ORINS. Gmelin, AED-CONF-63-161-10
CONF-212–		**(9th Annual Bioassay and Analytical Chemistry Conference, San Diego, Oct. 1963)**
5	18-1501	See LADC-5922
CONF-218–	18-2953	**(Symposium on Statistical Properties of Atomic and Nuclear Spectra, Stony Brook, N. Y., May 1963)**
CONF-227–		**(Problems in Irradiation–Capsule Experiments Conference, Germantown, Maryland, Oct. 8-10, 1963)**
1	18-2388	ORINS
2	18-2384	ORINS
3	18-2385	ORINS
4	18-2386	ORINS
5	18-2387	ORINS

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CONF-231–	(International Conference on Fundamental Aspects of Weak Interactions, Upton, N. Y., Sept. 1963)	
2	18-2684	ORINS. Gmelin, AED-CONF-63-153-1
CONF-232–	(International Colloquy on Neutron Diffusion and Diffraction, Grenoble, France, Sept. 1963)	
2	18-1599	See BNL-7373
CONF-239–	(International Symposium on Homotransplantation, Padua, Italy, May 1963)	
1	18-1367	ORINS
CONF-250–	(American Physical Society 1963 Summer Meeting in the West, Edmonton, Can., Aug. 1963)	
7	18-2511	ORINS. Gmelin, AED-CONF-63-131-3
11	18-1781	ORINS. Gmelin, AED-CONF-63-131-10
12	18-2962	ORINS. Gmelin, AED-CONF-63-131-8
CONF-251–	(Rotating Machinery for Gas Cooled Reactor Application, Gatlinburg, Tenn., Nov. 1963)	
2	18-1845	See LADC-6079
3	18-3063	See LADC-6050
CONF-255–	(8th Air Cleaning Seminar, Oak Ridge, Tenn., Oct. 1963)	
9	18-2390	See HW-SA-3220
CONF-285–	(7th Conference on Analytical Chemistry in Nuclear Technology, Gatlinburg, Tenn., Oct. 1963)	
2	18-1831	ORINS. Gmelin, AED-CONF-63-149-1
3	18-1499	Dep.(mc); $2.60(fs), $0.98(mf) OTS; Gmelin, AED-CONF-63-149-2
5	18-1596	ORINS. Gmelin, AED-CONF-63-149-3
CONF-286–	(18th Annual IAS Propulsion Meeting, Cleveland, Mar. 1963)	
1	18-2580	ORINS
CONF-288–	(2nd Conference on Kinetics Equilibria and Performance of High Temperature Systems, Western States Section of the Combustion Institute, Los Angeles, Apr. 1962)	
1	18-3027	ORINS
CONF-289–	(The Institute of Electrical and Electronics Engineers Region 3 Meeting, Richmond, Va., Apr. 1963)	
1	18-1447	ORINS
CONF-290–	(Conference on Molecular and Atomic Gas Beams, Charlottesville, Va., May 1963)	
1	18-2554	ORINS. Gmelin, AED-CONF-63-147-1
CONF-295–	(International Conference on High Energy Physics, Geneva, July 4–11, 1962)	
3	18-2595	See UCRL-10291
5	18-2594	See UCRL-10235
CONF-296–	(Symposium on Unimolecular Reactions in the Mass Spectrometer and Related Topics in Chemical Kinetics, Salt Lake City, July 1963)	
2	18-1721	ORINS. Gmelin, AED-CONF-63-144-4
CONF-297–	(International Conference and Exhibit on Aerospace Support, Washington, D. C., Aug. 1963)	
1	18-2015	ORINS. Gmelin, AED-CONF-63-142-3
CONF-298–	(Symposium on the Ionospheric Propagation of Very Low Frequency Radio Waves, Boulder, Colo., Aug. 1963)	
1	18-2750	ORINS. Gmelin, AED-CONF-63-156-1
CONF-301–	(International Conference on the Science of Superconductivity, Hamilton, New York, Aug. 1963)	
2	18-2285	ORINS. Gmelin, AED-CONF-63-148-16
4	18-2288	ORINS. Gmelin, AED-CONF-63-148-3
5	18-2775	ORINS. Gmelin, AED-CONF-63-148-4
6	18-2773	ORINS. Gmelin, AED-CONF-63-148-6
7	18-2774	ORINS. Gmelin, AED-CONF-63-148-7
10	18-2772	ORINS. Gmelin, AED-CONF-63-148-2
12	18-2287	ORINS. Gmelin, AED-CONF-63-148-17
13	18-2776	ORINS. Gmelin, AED-CONF-63-148-18
15	18-2778	ORINS. Gmelin, AED-CONF-63-148-11
CONF-303–	(3rd International Conference on the Mössbauer Effect, Ithaca, New York, Sept. 1963)	
1	18-2553	ORINS. Gmelin, AED-CONF-63-143-2
2	18-2973	ORINS. Gmelin, AED-CONF-63-143-1
5	18-1650	See BNL-7391
CONF-305–	(Symposium on Technical Aspects of Radiological Protection, Warsaw, Sept. 1962)	
1	18-2019	See CLOR-I-B-IBJ-18
CONF-306–	(The 10th Conference of Italian National Metallurgical Society, Naples, Sept. 22–26, 1963)	
1	18-2213	ORINS
CONF-307–	(Canadian Electronics Conference, Toronto, Ont., Canada, Sept.-Oct. 1963)	
1	18-2564	See DL-55
2	18-2563	ORINS. Gmelin, AED-CONF-63-165-1
CONF-308–	(American Institute of Aeronautics Meeting on Engineering Problems on Manned Interplanetary Exploration, Palo Alto, Calif., Sept. 1963)	
2	18-1839	ORINS. Gmelin, AED-CONF-63-154-2
CONF-309–	(EAES Symposium on Two Phase Flow Steady State Burnout and Hydrodynamic Instability, Studsvik, Sweden, Oct. 1963)	
1	18-3062	See KR-51
CONF-311–	(American Nuclear Society Aerospace Nuclear Safety National Topical Meeting, Albuquerque, New Mex., Oct. 1963)	
1	18-1955	See SC-DC-3248
3	18-1985	ORINS. Gmelin, AED-CONF-63-163-1
4	18-1987	ORINS. Gmelin, AED-CONF-63-163-2
5	18-3292	Dep.(mc); $2.60(fs), $0.83(mf) OTS; Gmelin, AED-CONF-63-163-4
CONF-312–	(3rd Conference on Nuclear Reactor Chemistry, 6th Conference on Analytical Chemistry in Nuclear Reactor Technology, Gatlinburg, Tenn., Oct. 1962)	
1	18-3139	See WAPD-T-1499
CONF-313–	(2nd National Meeting of the Society for Applied Spectroscopy, San Diego, Calif., Oct. 1963)	
1	18-3140	See WAPD-T-1615
CRFD–	(Canadian)	
1154	18-2217	Dep.; $1.50(AECL)
1156	18-2292	Dep.; $1.50(AECL)
CRGP–	(Canadian)	
1165	18-2555	Dep.; $4.00(AECL)
CRT–	(Canadian)	
1170	18-1862	Dep.; $1.00(AECL)
D–	(Misc.)	
2-90173	18-2381	ORINS
2-90173	18-2381	See CONF-299-1

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DL–	**(Non-AEC)**	
55	18-2564	Dep.; $0.50(AECL)
DLCS–		
3570204	18-3170	Dep.(mc); $1.10(fs), $0.80(mf) OTS
DP–		
865	18-3171	Dep.(mc); $5.60(fs), $1.88(mf) OTS
DPST–		
63-69-10	18-3172	Dep.(mc); $1.10(fs), $0.80(mf) OTS
63-74-9	18-2218	Dep.(mc); $1.10(fs), $0.80(mf) OTS
EANDC(OR)–	**(European-American Nuclear Data Committee)**	
22L	18-2837	Dep.(mc)
23L	18-2838	Dep.(mc)
EDR–	**(Non-AEC)**	
3113	18-3293	
ER–	**(Misc.)**	
6383	18-2296	See NP-13163
ETR–	**(Belgian)**	
128	18-1793	See NP-13269
133	18-1794	See NP-13270
136	18-1504	See NP-13271
137	18-1795	See NP-13272
EUR–	**(European Atomic Energy Community)**	
289.e	18-2020	Dep.(mc)
353.d	18-2197	Dep.(mc)
361.e	18-1367	See CONF-239-1
428.i	18-2213	See CONF-306-1
461.d,f,i,n	18-1947	Dep.(mc)
462.f	18-2142	Dep.(mc)
463.e	18-2219	Dep.(mc)
465.f	18-3173	Dep.(mc)
467.f	18-1500	Dep.(mc)
470.e	18-3095	Dep.(mc)
476.d	18-3174	Dep.(mc)
EURAEC–		
118	18-2198	Dep.(mc); $3.60(fs), $1.40(mf) OTS
176	18-2158	Dep.(mc); $3.60(fs), $1.34(mf) OTS
211	18-2175	Dep.(mc); $2.60(fs), $0.92(mf) OTS
218	18-3200	Dep.(mc); $1.10(fs), $0.80(mf) OTS
285	18-2183	Dep.(mc); $9.10(fs), $3.29(mf) OTS
522	18-2197	See EUR-353.d
607	18-2236	Dep.(mc); $5.60(fs), $1.94(mf) OTS
729	18-2237	Dep.(mc); $3.60(fs), $1.13(mf) OTS
748	18-2220	Dep.(mc); $5.60(fs), $1.91(mf) OTS
866	18-1865	See GEAP-4367
867	18-2165	See NCSC-2663-14
871	18-2221	See GEAP-4315
872	18-3091	See ACNP-63032
888	18-2162	See IITRI-B198-46
890	18-1867	See NYO-10487
FN-E–	**(Italian)**	
10	18-2198	See EURAEC-118
FTD-TT–	**(Non-AEC)**	
63-558	18-1379	OTS
63-585	18-1961	OTS
63-968	18-2409	OTS
FZK–	**(Non-AEC)**	
161-1	18-2293	
FZM–	**(Non-AEC)**	
3042	18-1781	See CONF-250-11
GA–	**(Misc.)**	
2178	18-3175	Dep.(mc); $14.00(fs), $6.29(mf) OTS
2847	18-3294	Dep.(mc); $10.50(fs), $4.13(mf) OTS
3005	18-3295	Dep.(mc); $10.50(fs), $4.37(mf) OTS
3809	18-3025	See CONF-78-17
4386	18-3176	Dep.(mc); $6.60(fs), $2.12(mf) OTS
GAMD–	**(Misc.)**	
489	18-3177	Dep.(mc); $1.60(fs), $0.80(mf) OTS
3712(Rev.)	18-3178	Dep.(mc); $2.60(fs), $0.92(mf) OTS
4238	18-3060	Dep.(mc); $3.60(fs), $1.19(mf) OTS
GEAP–	**(Misc.)**	
4090	18-3179	Dep.(mc); $10.50(fs), $4.40(mf) OTS
4094	18-3134	Dep.(mc); $9.60(fs), $3.62(mf) OTS
4286	18-3061	Dep.(mc); $6.60(fs), $2.24(mf) OTS
4315	18-2221	Dep.(mc); $4.60(fs), $1.67(mf) OTS
4358	18-1863	Dep.(mc); $2.60(fs), $0.86(mf) OTS
4362	18-1864	Dep.(mc); $3.60(fs), $1.16(mf) OTS
4367	18-1865	Dep.(mc); $8.60(fs), $3.05(mf) OTS
4390	18-1866	Dep.(mc); $1.60(fs), $0.80(mf) OTS
GEMP–		
28A	18-2159	Dep.; $0.75(OTS)
GNEC–		
282	18-3096	Dep.(mc); $26.00(fs), $17.12(mf) OTS
HMI-B–	**(German)**	
31	18-2143	Dep.(mc)
HPR–	**(Norwegian)**	
31	18-3180	Dep.(mc)
HW–		
68600-28	18-2160	Dep.; $0.50(OTS)
68600-32	18-3397	Dep.; $0.50(OTS)
68788	18-3386	Dep.(mc); $1.60(fs), $0.80(mf) OTS
76302	18-2161	Dep.; $2.25(OTS)
76449	18-3387	Dep.(mc); $3.60(fs), $1.13(mf) OTS
76928	18-3317	Dep.(mc); $10.10(fs), $3.83(mf) OTS
77609	18-1948	Dep.; $4.00(OTS)
77770	18-2126	Dep.(mc); $7.60(fs), $2.36(mf) OTS
79033	18-1605	Dep.; $0.50(OTS)
79141	18-1606	Dep.; $0.50(OTS)
HW-SA–		
2864	18-2332	Nucl. Sci. Eng., 17: 398-403(1963)
2934	18-3097	Dep.(mc); $2.60(fs), $1.10(mf) OTS
2940	18-3398	Dep.(mc); $1.60(fs), $0.80(mf) OTS
2953	18-2294	Dep.(mc); $1.60(fs), $0.80(mf) OTS
3004	18-1461	Am. Ind. Hyg. Assoc. J., 24: 492-6 (1963)
3105	18-2314	J. Appl. Phys., 34: 3637-8(1963)
3220	18-2390	Dep.(mc); $1.60(fs), $0.80(mf) OTS
I–	**(Misc.)**	
A2392-6	18-3188	See NYO-9791
IA–	**(Non-AEC)**	
778	18-3318	Dep.(mc)
828	18-2607	Nuovo Cimento (10), 29: 1068-79(1963)
IDO–		
11055	18-1488	Dep.(mc); $10.10(fs), $4.10(mf) OTS
11056	18-1708	Dep.(mc); $9.60(fs), $3.59(mf) OTS
11057	18-1709	Dep.(mc); $9.60(fs), $3.65(mf) OTS
11058	18-1710	Dep.(mc); $5.60(fs), $1.76(mf) OTS
14617	18-3389	Dep.; $0.75(OTS)

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16752	18-3098	Dep.; $2.00(OTS)
16921	18-2144	Dep.; $1.00(OTS)
16925	18-3399	Dep.; $2.75(OTS)
24043	18-3319	Dep.(mc); $21.00(fs), $11.87(mf) OTS
28584(Vol.I)	18-3181	Dep.(mc); $12.50(fs), $5.51(mf) OTS
28584(Vol.II)	18-3182	Dep.(mc); $21.00(fs), $12.17(mf) OTS
28584(Vol.III)	18-3183	Dep.(mc); $22.25(fs), $12.32(mf) OTS
28598	18-3184	Dep.; $3.00(OTS)
28609	18-3185	Dep.; $2.75(OTS)
IEA–	**(Brazilian)**	
61	18-1790	Dep.(mc)
IITRI–	**(Misc.)**	
A6042-2	18-3040	Dep.(mc); $3.60(fs), $1.34(mf) OTS
B198-46	18-2162	Dep.(mc); $2.60(fs), $1.07(mf) OTS
INSJ–	**(Japanese)**	
62	18-2400	Dep.(mc)
IP–	**(Misc.)**	
603	18-1607	Dep.(mc); $18.50(fs), $8.93(mf) OTS
IPPJ–	**(Japanese)**	
11	18-2979	Dep.(mc)
12	18-2723	Dep.(mc)
15	18-2980	Dep.(mc)
IS–		
629	18-2872	Nucl. Phys., 47: 561-83(1963)
642	18-1844	Dep.(mc); $1.60(fs), $0.80(mf) OTS
672	18-1658	Science, 142: 954-5(1963)
699	18-2704	Phys. Rev., 132: 2353-62(1963)
700	18-3400	Dep.; $5.50(OTS)
721	18-3401	Dep.; $0.75(OTS)
ISC–		
1029(Rev.)	18-2164	Dep.; $1.00(OTS)
ISS–	**(Italian)**	
63/37	18-2585	Dep.(mc)
JAERI–	**(Japanese)**	
4025	18-1608	
JINR–	**(Russian)**	
P-1327	18-2586	Dep.(mc)
P-1328	18-2587	Dep.(mc)
P-1383	18-2839	Dep.(mc)
JPL-TR–	**(Non-AEC)**	
32-518	18-2295	
JPRS–	**(Non-AEC)**	
21816	18-1342	$2.50(OTS)
JüL–	**(German)**	
136-ST	18-1952	Dep.(mc)
JüL-Bibl.–	**(German)**	
1	18-2572	Dep.(mc)
KAPL–		
2292	18-1882	Dep.(mc); $8.10(fs), $2.66(mf) OTS
KFK–	**(German)**	
161	18-1449	Biochem. Biophys. Res. Commun., 11: 393-8(1963)
163	18-1609	Dep.(mc)
168	18-2588	Dep.(mc)
171	18-1366	p.191-205 of "Diagnosis and Treatment of Radioactive Poisoning." Vienna, IAEA, 1963
KR–	**(Norwegian)**	
50	18-3186	Dep.(mc)
51	18-3062	Dep.(mc)
52	18-1610	Dep.(mc)
56	18-1791	Dep.(mc)
LA–		
2513	18-1611	Dep.; $0.75(OTS)
LADC–		
5688	18-3402	Dep.(mc); $10.10(fs), $4.07(mf) OTS
5694	18-3403	Dep.(mc); $2.60(fs), $0.98(mf) OTS
5730	18-2512	Dep.(mc); $1.10(fs), $0.80(mf) OTS
5731	18-3404	Dep.(mc); $1.60(fs), $0.80(mf) OTS
5789	18-2893	Nucl. Sci. Eng., 17: 433-4(1963)
5800	18-3007	Phys. Fluids, 6: 1707-13(1963)
5802	18-2003	Rev. Sci. Instr., 34: 1183-7(1963)
5805	18-1874	Rev. Sci. Instr., 34: 1218-19(1963)
5854	18-2916	Phys. Rev., 132: 2204-11(1963)
5904	18-2781	Dep.(mc); $1.10(fs), $0.80(mf) OTS
5907	18-2222	Dep.(mc); $1.60(fs), $0.80(mf) OTS
5922	18-1501	Dep.(mc); $1.60(fs), $0.80(mf) OTS
5924	18-2223	Dep.(mc); $1.60(fs), $0.80(mf) OTS
5968	18-2938	Phys. Rev. Letters, 11: 422-5(1963)
6019	18-3292	See CONF-311-5
6050	18-3063	Dep.(mc); $1.60(fs), $0.83(mf) OTS
6079	18-1845	Dep.(mc); $3.60(fs), $1.34(mf) OTS
LAS-TR–	**(Misc.)**	
161-41	18-2108	See TID-16050
LNF–	**(Italian)**	
62/66	18-2589	Dep.(mc)
MATT–		
206	18-3016	Phys. Fluids, 6: 1779-80(1963)
MATT-Q–		
20	18-2981	Dep.; $3.00(OTS)
MCW–		
1477	18-1502	Dep.; $0.50(OTS)
1481	18-1792	Dep.; $0.50(OTS)
MPI-PA–		
2/62	18-2878	See TID-19097
N–	**(Misc.)**	
63-21066	18-2293	See FZK-161-1
63-22572	18-2983	See NASA-TN-D-1992
NAA-SR-Memo–		
8817	18-3296	Dep.(mc); $3.60(fs), $1.19(mf) OTS
8949	18-3128	Dep.(mc); $3.60(fs), $1.22(mf) OTS
9043	18-3297	Dep.(mc); $9.10(fs), $3.38(mf) OTS
9088	18-2199	Dep.(mc); $1.60(fs), $0.80(mf) OTS
NASA-TN–	**(Misc.)**	
D-1111	18-2982	$0.50(OTS)
D-1992	18-2983	$1.00(OTS)
NAS-NRC–	**(Non-AEC)**	
Pub-1134	18-1448	$1.00(NAS)
NCSC–	**(Misc.)**	
2663-14	18-2165	Dep.(mc); $1.60(fs), $0.80(mf) OTS
NIRL-R–	**(British)**	

Report No.	Abstract No.	Availability
48	18-2497	Dep.(mc); $1.20(BIS); 6s. (HMSO)
NLCO–		
890	18-2166	Dep.; $1.00(OTS)
NMI–	(Misc.)	
1258	18-2226	Dep.; $1.75(OTS)
NP–	(AEC File No. for Non-AEC Reports)	
13163	18-2296	
13190	18-1723	Dep.(mc)
13261	18-2167	Dep.(mc)
13269	18-1793	
13270	18-1794	
13271	18-1504	
13272	18-1795	
13282	18-3405	Dep.(mc)
13283	18-1796	Dep.(mc)
13299	18-2573	
13300	18-1319	
13301	18-3187	Dep.(mc)
13309	18-1954	Dep.(mc)
13311	18-2147	Dep.(mc)
13315	18-1320	Dep.(mc)
13317	18-1321	Dep.(mc)
13356	18-2697	Phys. Letters, 7: 41-2(1963)
NP-tr–	(AEC File No. for Non-AEC Translations)	
1076	18-1883	Dep.(mc); $1.10(fs), $0.80(mf) JCL
NYO–		
8104	18-3406	Dep.(mc); $10.10(fs), $3.92(mf) OTS
9766	18-2840	Dep.(mc); $2.60(fs), $1.04(mf) OTS
9791	18-3188	Dep.(mc); $26.00(fs), $18.20(mf) OTS
10038	18-1797	Dep.(mc); $10.10(fs), $3.89(mf) OTS
10487	18-1867	Dep.(mc); $5.60(fs), $1.73(mf) OTS
10710	18-3407	Dep.(mc); $3.60(fs), $1.13(mf) OTS
ORNL–		
2221(Pts.1-5)(Del.)	18-3298	Dep.(mc); $21.00(fs), $9.66(mf) OTS
3385	18-1798	Dep.; $2.50(OTS)
3488	18-1490	Dep.; $2.75(OTS)
3494	18-1616	Dep.; $10.50(fs), $4.25(mf) OTS
3496	18-1799	Dep.; $2.50(OTS)
3512	18-2170	Dep.; $1.60(fs), $0.80(mf) OTS
3516	18-1800	Dep.; $1.00(OTS)
3540	18-2498	Dep.; $4.00(OTS)
ORNL-TM–		
645	18-1801	Dep.(mc); $2.60(fs), $1.07(mf) OTS
658	18-2128	Dep.(mc); $4.60(fs), $1.55(mf) OTS
662	18-3321	Dep.(mc); $1.60(fs), $0.80(mf) OTS
694	18-1846	Dep.(mc); $2.60(fs), $0.86(mf) OTS
719	18-2565	Dep.(mc); $1.60(fs), $0.80(mf) OTS
724	18-1505	Dep.(mc); $1.60(fs), $0.80(mf) OTS
725	18-3100	Dep.(mc); $1.10(fs), $0.80(mf) OTS
726	18-2148	Dep.(mc); $1.10(fs), $0.80(mf) OTS
OTS–	(Misc.)	
62-11069(No.3)	18-1380	$3.50(OTS)
63-11450-1	18-1898	Mining and Metallurgy Quarterly. Translation of Rudarsko-Met. Zbornik, No. 1, 1963. $1.00(OTS)
63-41112	18-1342	For translation see JPRS-21816
PAN–	(Polish)	
268	18-2402	Dep.
PATENTS	(British)	3s. 6d. each, U. K. Patent Office
941,687	18-1934	
941,781	18-3084	
941,782	18-3085	
941,791	18-1832	
941,804	18-2290	
PATENTS	(U. S.)	
3,109,308	18-2016	
3,109,704	18-1705	
3,109,745	18-2214	
3,109,797	18-3159	
3,109,798	18-1783	
3,109,801	18-3028	
3,109,802	18-3127	
3,109,815	18-1841	
3,109,929	18-3086	
3,109,931	18-1858	
3,110,557	18-3393	
3,110,560	18-1706	
3,110,653	18-1784	
3,110,654	18-3087	
3,110,655	18-3088	
3,110,656	18-3385	
3,110,657	18-3089	
3,110,658	18-3158	
3,110,803	18-3090	
3,110,806	18-2099	
3,110,807	18-2017	
3,110,808	18-2100	
3,110,811	18-2018	
PG-Report–	(British)	
451	18-1506	Dep.; $0.40(BIS); 2s. (HMSO)
501	18-1507	Dep.; $0.40(BIS); 2s. (HMSO)
519	18-1617	Dep.
522	18-1508	Dep.; $0.40(BIS); 2s. (HMSO)
PLASTEC–	(Non-AEC)	
14	18-2171	$2.50(OTS)
PPAD–		
475D	18-1990	Dep.(mc); $1.60(fs), $0.80(mf) OTS
480-D	18-1991	Dep.(mc); $5.60(fs), $1.79(mf) OTS
498E	18-2499	Dep.(mc); $2.60(fs), $0.86(mf) OTS
PR-P–	(Canadian)	
58	18-2403	Dep.; $2.00(AECL)
PRWRA-GNEC–		
6	18-3189	Dep.; $33.50(fs), $25.22(mf) OTS
PUC–		
1963-108	18-2915	Phys. Rev., 132: 2200-3(1963)
1963-111	18-2926	Phys. Rev., 132: 2582-6(1963)
PWA–	(Non-AEC)	
2227(Vol.1)	18-3299	
2227(Vol.2)	18-3300	
2227(Vol.3)	18-3301	
PWAC–	(Misc.)	
383	18-3064	Dep.; $1.25(OTS)
R–	(Misc.)	
63SD87	18-2984	
REIC–	(Misc.)	
27	18-2297	Dep.; $2.00(OTS)
RHD–	(Non-AEC)	
Vol.IV, No.10	18-1982	Radiological Health Data [Monthly Report], Volume IV, Number 10. (Public Health Service, Washington,

Report No.	Abstract No.	Availability
		D. C.). 1963, $0.50(GPO)
RISÖ–	**(Danish)**	
44	18-2023	Dep.(mc)
62	18-3029	Dep.(mc)
RRL–		
106	18-1726	Dep.(mc); $2.60(fs), $1.04(mf) OTS
RT-BIO–	**(Italian)**	
(63)22	18-1440	Strahlentherapie, Sonderbaende, 51: 156-9(1962)
RT-EL–	**(Italian)**	
(63)9	18-2024	Dep.(mc)
RT-FI–	**(Italian)**	
(63)37	18-2842	Dep.(mc)
RTD-TDR–	**(Non-AEC)**	
63-4133	18-1727	
S–	**(Misc.)**	
62	18-1946	See CEX-61.6.3
SC–	**(Misc.)**	
4730(RR)	18-1842	Dep.; $2.75(OTS)
4964(RR)	18-3408	Dep.; $0.50(OTS)
SC-DC–		
3248	18-1955	Dep.(mc); $1.60(fs), $0.80(mf) OTS
SC-DR–		
168-63	18-3409	Dep.(mc); $1.10(fs), $0.80(mf) OTS
SC-TM–		
83-62(71)	18-3410	Dep.(mc); $9.60(fs), $3.65(mf) OTS
394-60(72)	18-1992	Dep.(mc); $1.60(fs), $0.80(mf) OTS
SCDC–		
3129	18-3412	See TID-18403
3143	18-1638	See TID-18407
SCPRI(RM)–	**(French)**	
IX-1963	18-1956	Dep.(mc)
SM–	**(Misc.)**	
44/18	18-1375	See BNL-7371
50/26	18-1728	See TID-19650
SPM–	**(French)**	
710	18-3041	Dep.(mc)
SRIA–		
113	18-3042	Dep.; $0.75(OTS)
SRO–		
95	18-3190	Dep.(mc); $1.10(fs), $0.80(mf) OTS
STI-PUB–	**(International Atomic Energy Agency)**	
56a	18-2365	Radiation Damage in Reactor Materials. 1963. $15.00; Sch 315,-; 90.stg; F.fr.60.-; DM 52.50(IAEA)
71	18-1911	Radioisotopes in Hydrology. Proceedings of the Symposium on the Application of Radioisotopes in Hydrology held by the International Atomic Energy Agency in Tokyo, 5-9 March, 1963. $9.00; 189s; 54s.stg; NF 36; DM 31.50(IAEA)
STL–	**(Misc.)**	
6306	18-3101	Dep.(mc); $3.60(fs), $1.22(mf) OTS
TID–		
3544(Rev.1)	18-2172	Dep.; $2.50(OTS)
5360(Suppl.4)	18-1957	Dep.; $0.75(OTS)
6506(Pt.1, 2nd.Ed.)	18-2173	Dep.; $3.50(OTS)
6613(Suppl.4)	18-2107	Dep.; $2.75(OTS)
7015(Indexes)	18-1509	Dep.; $2.50(OTS)
7663	18-3322	Dep.; $13.00(OTS)
7665	18-3136	Dep.; $2.50(OTS)
16050	18-2108	Dep.; $3.50(OTS)
16764(Suppl.1)	18-1958	Dep.; $0.75(OTS)
18355	18-1993	Dep.(mc); $1.10(fs), $0.80(mf) OTS
18358	18-2025	Dep.(mc); $2.60(fs), $1.01(mf) OTS
18367	18-3411	Dep.(mc); $1.60(fs), $0.80(mf) OTS
18374	18-2232	Dep.(mc); $1.10(fs), $0.80(mf) OTS
18403	18-3412	Dep.(mc); $1.10(fs), $0.80(mf) OTS
18407	18-1638	J. Inorg. Nucl. Chem., 25: 1445-55(1963
18551	18-2703	Phys. Rev., 132: 2337-45(1963)
18598	18-2207	Nucl. Sci. Eng., 17: 365-70(1963)
18785	18-2883	Nucl. Phys., 48: 75-82(1963)
18853	18-1905	Science, 142: 1163-5(1963)
19097	18-2878	Nucl. Phys., 47: 671-90(1963)
19146	18-1519	Anal. Chem., 35: 2135-8(1963)
19152	18-2934	Phys. Rev., 132: 2650-6(1963)
19171	18-2072	Radiation Res., 20: 423-30(1963)
19193	18-2843	Dep.(mc); $4.60(fs), $1.49(mf) OTS; Gmelin, AED-CONF-63-048-114
19422	18-2500	Dep.(mc); $12.50(fs), $5.39(mf) OTS
19422(Suppl.II)	18-2501	Dep.(mc); $9.10(fs), $3.35(mf) OTS
19448	18-1360	Nature, 200: 271(1963)
19493(Sect.1)	18-1847	Dep.(mc); $22.25(fs), $9.89(mf) OTS
19516	18-1376	Dep.(mc); $1.60(fs), $0.80(mf) OTS
19529	18-1340	Dep.(mc); $6.60(fs), $2.15(mf) OTS
19559	18-1899	Dep.(mc); $10.50(fs), $4.22(mf) OTS
19576	18-2641	Phys. Rev., 132: 2540-4(1963)
19592	18-2129	Dep.(mc); $14.50(fs), $6.56(mf) OTS
19608	18-1341	Dep.(mc); $11.50(fs), $4.88(mf) OTS
19613	18-1712	Dep.(mc); $1.10(fs), $0.80(mf) OTS
19622	18-1322	Dep.(mc); $1.60(fs), $0.80(mf) OTS
19650	18-1728	Dep.(mc); $5.60(fs), $1.73(mf) OTS
19651	18-2404	Dep.(mc); $19.75(fs), $9.35(mf) OTS
19654	18-2844	Dep.(mc); $7.60(fs), $2.57(mf) OTS
19655	18-1377	Dep.(mc); $3.60(fs), $1.25(mf) OTS
19657	18-2845	Dep.(mc); $3.60(fs), $1.31(mf) OTS
19661	18-1868	Dep.(mc); $1.10(fs), $0.80(mf) OTS
19663	18-1729	Dep.(mc); $3.60(fs), $1.28(mf) OTS
19665	18-2405	Dep.(mc); $1.10(fs), $0.80(mf) OTS
19667	18-2590	Dep.(mc); $1.10(fs), $0.80(mf) OTS
19668	18-1730	Dep.(mc); $6.60(fs), $2.12(mf) OTS
19669	18-1959	Dep.(mc); $5.60(fs), $1.73(mf) OTS
19670	18-1323	Dep.(mc); $1.10(fs), $0.80(mf) OTS
19671	18-1731	Dep.(mc); $3.60(fs), $1.16(mf) OTS
19672	18-2685	Dep.(mc); $4.60(fs), $1.70(mf) OTS
19678	18-3043	Dep.(mc); $11.50(fs), $4.88(mf) OTS
19680	18-1618	Dep.(mc); $1.60(fs), $0.80(mf) OTS
19682	18-2591	Dep.(mc); $1.60(fs), $0.80(mf) OTS
19683	18-1324	Dep.(mc); $1.60(fs), $0.80(mf) OTS
19685	18-2026	Dep.(mc); $1.10(fs), $0.80(mf) OTS
19686	18-3413	Dep.(mc); $1.10(fs), $0.80(mf) OTS
19687	18-3414	Dep.(mc); $2.60(fs), $0.86(mf) OTS
19688	18-2027	Dep.(mc); $3.60(fs), $1.34(mf) OTS
19689	18-2028	Dep.(mc); $2.60(fs), $0.95(mf) OTS
19690	18-2149	Dep.(mc); $3.60(fs), $1.16(mf) OTS
19691	18-2029	Dep.(mc); $1.60(fs), $0.80(mf) OTS
19692	18-2030	Dep.(mc); $5.60(fs), $1.82(mf) OTS
19694	18-3415	Dep.(mc); $3.60(fs), $1.13(mf) OTS
19695	18-2031	Dep.(mc); $1.60(fs), $0.80(mf) OTS
19696	18-2032	Dep.(mc); $1.10(fs), $0.80(mf) OTS
19697	18-3416	Dep.(mc); $1.10(fs), $0.80(mf) OTS

Report No.	Abstract No.	Availability
19698	18-3417	Dep.(mc); $1.10(fs), $0.80(mf) OTS
19699	18-3418	Dep.(mc); $1.10(fs), $0.80(mf) OTS
19700	18-3419	Dep.(mc); $3.60(fs), $1.22(mf) OTS
19701	18-3420	Dep.(mc); $1.10(fs), $0.80(mf) OTS
19702	18-3421	Dep.(mc); $4.60(fs), $1.67(mf) OTS
19703	18-3422	Dep.(mc); $1.10(fs), $0.80(mf) OTS
19704	18-3423	Dep.(mc); $1.60(fs), $0.80(mf) OTS
19705	18-3424	Dep.(mc); $1.60(fs), $0.80(mf) OTS
19706	18-2592	Dep.(mc); $2.60(fs), $0.92(mf) OTS
19707	18-2593	Dep.(mc); $4.60(fs), $1.46(mf) OTS
19708	18-1802	Dep.(mc); $6.60(fs), $2.06(mf) OTS
19709	18-2846	Dep.(mc); $3.60(fs), $1.34(mf) OTS
19712	18-3425	Dep.(mc); $1.60(fs), $0.80(mf) OTS
19714	18-2847	Dep.(mc); $43.50(fs), $37.55(mf) OTS
19715	18-3426	Dep.(mc); $3.60(fs), $1.22(mf) OTS
19716	18-3427	Dep.(mc); $3.60(fs), $1.13(mf) OTS
19732	18-3428	Dep.(mc); $1.10(fs), $0.80(mf) OTS
19733	18-3429	Dep.(mc); $2.60(fs), $0.92(mf) OTS
19737	18-3430	Dep.(mc); $1.10(fs), $0.80(mf) OTS Nature, 200: 877(1963)
19739	18-3431	Dep.(mc); $1.10(fs), $0.80(mf) OTS
UAC–		
7219	18-3411	See TID-18367
7228	18-2025	See TID-18358
7259	18-2232	See TID-18374
UCID–		
4610	18-1949	See IDO-16925(p.41-8)
UCRL–		
6588	18-1843	Dep.(mc); $1.60(fs), $0.80(mf) OTS
7023	18-3102	Dep.; $1.25(OTS)
7248	18-2888	Nucl. Phys., 48: 152-8(1963)
7322	18-2406	Dep.; $1.50(OTS)
7477	18-3346	Dep.; $1.00(OTS)
7489	18-2033	Dep.; $0.50(OTS)
8839	18-1620	Dep.(mc); $1.60(fs), $0.80(mf) OTS
10235	18-2594	Dep.(mc); $1.60(fs), $0.80(mf) OTS
10291	18-2595	Dep.(mc); $1.10(fs), $0.80(mf) OTS
10407	18-2633	Phys. Rev., 132: 2296-2304(1963)
10408	18-2634	Phys. Rev., 132: 2305-8(1963)
10409	18-2635	Phys. Rev., 132: 2309-13(1963)
10410	18-2636	Phys. Rev., 132: 2314-22(1963)
10455	18-3432	Dep.(mc); $13.50(fs), $6.11(mf) OTS
10722	18-1637	J. Inorg. Nucl. Chem., 25: 1423-9(1963)
10852	18-2985	Dep.; $2.75(OTS)
10879	18-2233	Dep.; $0.75(OTS)
10911	18-2906	Phys. Letters, 7: 67-9(1963)
10920	18-1619	Dep.(mc); $1.60(fs), $0.80(mf) OTS; Gmelin, AED-CONF-63-133-24
10921	18-2661	Phys. Rev. Letters, 11: 439-41(1963)
10934	18-1325	Dep.; $2.50(OTS)
10986	18-2034	Dep.; $0.75(OTS)
10996	18-1835	Dep.; $1.50(OTS)
11000	18-2664	Phys. Rev. Letters, 11: 447-8(1963)
11006	18-2848	Dep.; $2.25(OTS)
UCRL-Trans–		
994(L)	18-3434	Dep.(mc); $1.10(fs), $0.80(mf) JCL
995(L)	18-2728	Dep.(mc); $1.60(fs), $0.80(mf) JCL or OTS
997(L)	18-3435	Dep.(mc); $1.10(fs), $0.80(mf) JCL or OTS
1003(L)	18-2410	Dep.(mc); $1.10(fs), $0.80(mf) JCL or OTS
UNC–	**(Misc.)**	
5060	18-2234	Dep.(mc); $2.60(fs), $1.01(mf) OTS
UR–		
634	18-1343	Dep.(mc); $3.60(fs), $1.25(mf) OTS
USBM-U–	**(Misc.)**	
1082	18-2174	Dep.; $0.50(OTS)
USNRDL-TR–	**(Non-AEC)**	
659	18-1960	$17.50(OTS)
WANL-PR–	**(Misc.)**	
(N)-003	18-2205	Dep.(mc); $3.60(fs), $1.31(mf) OTS
WAPD-T–		
1290	18-1869	Dep.(mc); $15.00(fs), $6.89(mf) OTS
1499	18-3139	Dep.(mc); $1.60(fs), $0.80(mf) OTS
1615	18-3140	Dep.(mc); $1.60(fs), $0.80(mf) OTS
WAPD-TM–	**(Misc.)**	
272	18-2782	Dep.; $2.25(OTS)
379	18-2150	Dep.; $2.00(OTS)
396	18-2783	Dep.; $0.50(OTS)
WCAP–	**(Misc.)**	
1818(Vol.I)(Del.)	18-2566	Dep.(mc); $13.50(fs), $6.17(mf) OTS
1818(Vol.II)(Del.)	18-2574	Dep.(mc); $12.00(fs), $5.30(mf) OTS
2009	18-3197	Dep.(mc); $11.00(fs), $4.52(mf) OTS
2040	18-3198	Dep.(mc); $9.60(fs), $3.56(mf) OTS
2070	18-3199	Dep.(mc); $12.50(fs), $5.33(mf) OTS
2211	18-3065	
2403	18-2035	Dep.(mc); $1.60(fs), $0.80(mf) OTS
WIS-TCI–	**(Non-AEC)**	
32	18-2407	
WT–	**(Misc.)**	
7	18-1888	Dep.(mc); $7.60(fs), $2.57(mf) OTS
510	18-1889	Dep.(mc); $4.60(fs), $1.61(mf) OTS
1468	18-1836	Dep.; $5.50(OTS)
Y–		
1447	18-1510	Dep.; $0.50(OTS)
Y-KN–		
629	18-2145	See IDO-16925(p.67-75)
ZFK-PHA–	**(German)**	
6	18-1994	Dep.(mc)
ZFK-WF–	**(German)**	
20	18-3141	Dep.(mc)

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